

SNR EXHIBIT 4

**UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK**

IN RE: INTEREST RATE SWAPS ANTITRUST
LITIGATION

No. 16 MD 2704 (JPO)

This Document Relates To: All Class Actions

**REPLY REPORT OF DARRELL DUFFIE IN SUPPORT OF CLASS PLAINTIFFS'
MOTION FOR CLASS CERTIFICATION**

SUBJECT TO PROTECTIVE ORDER – PRIVILEGED AND HIGHLY CONFIDENTIAL

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I. INTRODUCTION

A. Anonymous all-to-all trade: viable and cost-saving for all buy-side firms

1. As I set out in detail in my opening report, absent the alleged blocking behavior of the Defendant dealers, there would have been significant anonymous all-to-all trade before 2013 of the IRS products at issue in this case. In both my opening report and this report, unless otherwise specified my opinions are focused solely on the four most common and standardized classes of IRS instruments—plain-vanilla fixed-floating interest rate swaps, forward rate agreements, overnight index swaps, and single-currency basis swaps.¹ Record evidence, including deposition testimony elicited since the filing of my opening report, suggests that, consistent with the opinions I expressed in my opening report, the trade platforms Javelin, Tera, trueEX, and Bloomberg, as well as existing inter-dealer-broker platforms, would have had the capacity to support anonymous all-to-all (“AA2A”) trade of these interest-rate-swap (“IRS”) instruments by 2012 in a but-for world without dealers’ alleged efforts to block the success of these platforms.
2. Anonymous all-to-all trade of the most actively traded types of each of these four standardized classes of IRS products was viable in the absence of the alleged blocking behavior of dealers given the following primary enabling elements.
 - The most actively traded types of each of these four product classes had long before been completely standardized with common market-wide ISDA contractual language and simple standard terms. These standardized products were operationally suitable for straight-through processing and central clearing.
 - For actively traded types within each of these four product classes, volumes of trade and breadth of trade interest among buy-side firms was substantial, even before being stimulated by AA2A trade, and would have been far greater had all-to-all anonymous trade actually been available.
 - By 2005, central clearing of standardized IRS had already reached tens of trillions of dollars of outstanding notional. Central clearing of actively traded types of all four classes of products was available by 2012.
 - With the momentum for the reform of the OTC derivatives market that was created in the wake of the financial crisis, and in particular given the Dodd-Frank Act and implementing CFTC rules, the trade platform operators that I have identified had a strong commercial interest to set up platforms for anonymous all-to-all trade of IRS products. They had the necessary expertise, capital, technology, and business initiative to offer anonymous all-to-all trade. The record evidence that I have seen indicates that these platforms did not, however, have meaningful quote provision by dealers.

¹ As I explained at my deposition, my opinions in this matter relate to the trade of this specific scope of IRS instruments. Duffie Dep. Tr. 321:18-20.

- If acting in their individual interests, some major dealers would have reacted by offering meaningful market-making services on anonymous all-to-all platforms. Buy-side investors would have sent significant quantities of orders to these platforms. Bid-ask spreads would have narrowed and volume and breadth of participation by buy-side firms and market-makers would have increased in response. A positive feedback, or “snowballing,” of volumes of trade and bid-ask spread competition would have set in. Once all-to-all trade platforms had begun to handle a non-trivial amount of trade volume in the most actively traded IRS products, AA2A trade platform operators would have introduced somewhat less actively traded products. Of total trade of these IRS products, the majority would have been traded on anonymous all-to-all venues in a matter of months.
3. With active AA2A trade, all or nearly all buy-side firms would have benefited from higher competition for their trade demands, better ability to match buyers and sellers, and heightened price transparency, all contributing to better buy-side price terms. Buy-side firms would also have profited from the opportunity to act as providers of immediacy to others on anonymous all-to-all trade venues. Further, dealers would have achieved inventory-rebalancing cost reductions through all-to-all trade, and through the effects of competition would have passed some of those cost savings on to buy-side firms.
 4. Given the types of standardized IRS products at issue, buy-side firms would have benefited even when they chose not to trade on anonymous all-to-all platforms in the but-for world because of the disciplining of dealer quotes associated with superior price transparency emanating from AA2A platforms and from the option of buy-side firms to substitute with trades on AA2A platforms of the same or related products when dealer quotes were not sufficiently attractive.
 5. None of the analysis or opinions in the reports of the Defendants’ experts, Dr. Christopher Culp and Professor Michael Johannes, changes the opinions that I expressed in my opening report. The assertions of Dr. Culp and Professor Johannes concerning the viability of anonymous all-to-all trade and its benefits to buy-side firms suffer from two serious logical gaps: (i) a failure to incorporate the benefits to buy-side firms in the but-for world of having access to *both* customer-to-dealer requests for quotes and anonymous all-to-all trade, and (ii) a conflation of trade volumes and bid-offer spreads in the actual world with those that would have prevailed in the but-for world. I strongly disagree with their conclusions regarding the viability of AA2A trade and the associated buy-side benefits, which rest on these and other oversights or mistakes that I discuss in this report.
 6. Moreover, while Professor Johannes and Dr. Culp suggest that anonymous all-to-all trade was generally neither viable nor desirable for buy-side firms, their reports did not name any buy-side firms that would prefer not to have access to anonymous all-to-all trade. For the reasons that I describe in my opening report and in this report, the availability of anonymous all-to-all trade of the types of standardized IRS instruments at issue in this case would only benefit buy-side firms.

7. Professor Johannes and Dr. Culp also fail to address the evidence that dealers, buy-side firms, incumbent platform operators, and entrant platform operators all expected the IRS market to move toward all-to-all trade. The new platform operators acted in accordance with that assessment, including through substantial financial investments. My opening report presented evidence that senior market-structure experts employed by the Defendant dealers believed that anonymous all-to-all trade represented a serious threat to their business models and believed that their buy-side customers wanted access to this form of trade.²
8. In this report, I cite additional record evidence of specific named buy-side firms that stated a desire to trade on anonymous all-to-all venues, for the benefits of anonymity and better execution prices. When the Dodd-Frank Act forced the majority of buy-side IRS trade onto electronic swap execution facilities (“SEFs”), the operators of start-up IRS trade platforms (Javelin, trueEX, and Tera) saw an opportunity to invest millions of dollars of their own capital³ to begin offering anonymous all-to-all trade of IRS products. The reports of Dr. Culp and Professor Johannes do not even attempt to explain why these entrepreneurs and Bloomberg invested heavily in anonymous all-to-all trade if, as Professor Johannes claims, this form of trade was neither viable nor beneficial to buy-side firms.

B. Access to both all-to-all and D2C trade dominates access to only D2C trade

9. As I state in my opening report, access to anonymous all-to-all trade does not remove the option to trade via request for quote (“RFQ”) with dealers whenever a buy-side firm finds this preferable. Increasing the menu of available trading venues by adding AA2A trade platforms does not make any buy-side firm worse off. To the contrary, adding this valuable option, with all of the benefits that I have described, would only make buy-side firms better off. In my opening report I offered case evidence,⁴ which I extend in this reply report, of specific large buy-side firms that prefer to have access to both D2C RFQ

² Duffie Rep. ¶¶115-122, 124-126. As an additional example of record evidence, which I did not cite in my opening report, [REDACTED]

³ For example, I will later discuss the testimony of Sunil Hirani. Hirani Dep. Tr. 467-468.

⁴ Duffie Rep. ¶¶115, 118-122.

trade and AA2A trade. My opening report has already offered examples and a detailed analysis of the preference for D2C RFQ venues for some types of trades and AA2A venues for others.

10. Dr. Culp and Professor Johannes note that buy-side firms would, at times, prefer the price they could obtain for a given trade with an off-exchange request for quote from dealers over that available at an anonymous all-to-all venue. I agree – and said so in my opening report. The reasoning underlying this fact applies to all asset classes, including listed equities. Professor Johannes concludes that “a transition to AA2A trading [of the IRS at issue] would have harmed many potential class members.”⁵ This conclusion does not follow. Indeed, the Defendants’ experts do not – and to my knowledge could not – identify a single buy-side firm that would not benefit from a significant migration of standardized IRS instrument trade to anonymous all-to-all venues. I am aware of no buy-side firm that would prefer to avoid having access to anonymous all-to-all trade of such IRS instruments.
11. The reports of Professor Johannes and Dr. Culp omit discussion of abundant case evidence of buy-side interest in the option to conduct AA2A trade. Dr. Culp and Professor Johannes do not adequately consider the benefit to buy-side firms in the but-for world of the option to choose, trade by trade, the most appropriate venue for each transaction, and to benefit even in their non-AA2A trading from the price transparency, competition, and price discipline imposed on dealers by the availability of AA2A trade in the same or similar IRS instruments.
12. In this report, I also consider the arguments of Professor Johannes and Dr. Culp that are based on comparisons with anonymous all-to-all trade in other markets. For example, I review the soundness of the Defendants’ experts’ arguments when placed in the context of the “upstairs” and “downstairs” markets for listed equities. Buy-side firms execute some of their trades of public equities directly with dealers in the “upstairs” (over-the-counter, or “OTC”) market, but they obviously benefit from the additional opportunity to trade on equity exchanges whenever exchange trade provides better execution. No financial expert would reasonably suggest that firms trading in the upstairs market for public equities do not also trade equities on exchange limit order books, or that the existence of equity exchanges does not benefit them.
13. The Defendants’ experts point to examples of instruments that are less actively traded on exchanges, such as contracts for the less actively traded delivery months for Eurodollar futures, as though this evidences a lack of viability of exchange trading.⁶ It is not logically correct to use data arising from the existence of an activity as evidence that the activity is not viable. These examples instead support the point that I made in my opening report, that AA2A trade of some less heavily traded IRS products would occur in the but-for world, given the existence of highly active AA2A trade of related products. For moderately actively traded IRS products, if there is not enough volume for limit-order-

⁵ Johannes Rep. ¶11.

⁶ Culp Rep. ¶165; Johannes Rep. ¶¶59, 64, 167-171.

book trading, then anonymous all-to-all RFQ or other AA2A protocols can be deployed. As an example of how the anonymous all-to-all RFQ protocol can be successfully deployed in markets where trade activity is dispersed across many different less heavily traded different instruments, I will later describe the success in the U.S. corporate bond market of the Open Trading platform of MarketAxess.

14. As I explain in my opening report, when there exists parallel OTC and exchange trading venues for a financial instrument, the price that a dealer offers to a customer for an OTC trade is disciplined by (i) the ability of the customer to observe prices streaming from the exchange and (ii) the common knowledge between the dealer and customer that if the dealer's off-exchange quote is not sufficiently attractive, the customer can place some or all of the order on the exchange. The Defendants' experts dispute these price-disciplining effects, which, as I will explain again here, are well supported by standard economic principles that I offered in my opening report. The Defendants' experts offer no reason that standard accepted economic principles of cross-product demand substitution and market transparency would not apply to closely related products in the IRS market. Later in this report, I cite empirical evidence of the price disciplining effect of AA2A trade on non-AA2A pricing, including evidence from academic research on the upstairs (OTC) and downstairs (exchange) market for equities, the corporate bond market, and the commodities market for steel, which experienced a natural experiment in 2008 with the introduction of AA2A trade of steel futures contracts on the London Metals Exchange and the New York Mercantile Exchange. Among other examples, I will cite the opinion of Germany's federal debt management bureau that prices in the dealership-based over-the-counter market for German government bonds are based primarily on price discovery from the exchange-based market for German government bond futures.
15. The existence of an active exchange also reduces dealer costs for rebalancing inventories. As I explained in my opening report, these cost reductions are reflected in tighter bid-offer spreads in off-exchange quotes, an additional benefit to buy-side firms.⁷ I will discuss later in this report additional empirical evidence on trueEX's Portfolio Terminations and Compactions tool, with which trueEX offered electronic execution for rebalancing inventories.
16. Some buy-side firms also benefit on AA2A venues from profits generated by providing their own quotes to others. This is well established behavior in exchange markets, where buy-side firms frequently post limit orders, offering liquidity to others, and not just paying for liquidity offered by others.
17. In summary, buy-side firms benefit from lower trading costs associated with the existence of anonymous all-to-all trade of a given IRS product or related products primarily through: (i) heightened competition and price transparency for their AA2A trades, (ii) more rigorous disciplining of OTC dealer quotes to customers, (iii) passthrough to customers of some of the associated reduction of dealer inventory-management costs, and (iv) profits from offering liquidity to others at AA2A venues.

⁷ Duffie Rep. ¶233.

18. Actual-world IRS trade activity is not representative of the but-for world. Dr. Culp and Professor Johannes conflate trade volumes and bid-offer spreads in the actual world with those that would have prevailed in the but-for world. Because the blocking of trade activity on AA2A venues was the very objective of the alleged conspiracy of the Defendant dealers, it is not correct to argue that anonymous all-to-all trade of IRS lacked viability in the but-for world on the basis of trade activity levels in the actual world. By analogy, in the face of an allegation of undue exercise of monopoly power, it would be logically incorrect to argue that a potential market entrant was incapable of offering a popular product because it had been unable to actually obtain a viable share of the market.
19. Likewise, the Defendants' experts' comparisons of prices across venues in the actual world are not instructive of relative buy-side trading costs, AA2A versus D2C RFQ, in the but-for world.
20. In his deposition in this matter, Professor Johannes admitted that when using CLOB trading data from Javelin and trueEX he "wasn't making [an] explicit assumption one way or the other" regarding whether the allegations of conspiracy are true.⁸ He claimed that he believes that comparing these trading data is "informative," despite the Plaintiffs' allegations that these platforms were boycotted.⁹ Professor Johannes simply asserted, without offering a foundation, his belief that the comparison of actual-world trade data from the CLOBs of Javelin and trueEX was relevant because these data are consistent with his view that swaps are not suited to anonymous CLOB execution.¹⁰
21. The Defendants' experts claim that, other than a few benchmark IRS, IRS products are too thinly traded to support active AA2A trade. I explained at length in my opening report that AA2A trade of the standardized IRS products would have been far more liquid in the but-for world than in the actual world. The introduction of AA2A trade of these IRS products would have started with actively traded benchmark IRS and snowballed from there over a period of months to include other IRS products. The most thinly traded IRS products would not have made this transition, but buy-side trade in these thinly traded products would have still benefited, through the impact of AA2A trade of related IRS products on dealer price discipline and through substitution options.
22. The advent of AA2A trade increases trade volumes and depth for the overall market (including OTC trading) because of reduced average transaction costs through greater competition and price transparency, through the entry of new market makers such as principal trading firms, and from the accessibility of the market to smaller buy-side firms. The equity options market is a good example of how this actually happened, as I explain in my original report and will elaborate later in this report.

⁸ Johannes Dep. Tr. 184:22-185:8.

⁹ Johannes Dep. Tr. 182:19-183:10.

¹⁰ Johannes Dep. Tr. 238:8-25.

23. In the remainder of this reply report, I will elaborate on these points and raise a number of other concerns about assertions made by the Defendants' experts.

II. BUYSIDE FIRMS BENEFIT FROM BOTH D2C RFQ AND AA2A TRADE

A. Buyside firms want both RFQ and anonymous all-to-all venues

24. That buyside firms want access to the benefits of AA2A IRS trade venues is a matter of record in this case. This is no surprise. As I explain in my opening report, access to AA2A trade (i) does not preclude access to D2C RFQ trade, (ii) provides better buyside execution prices for the majority of trades, (iii) lowers operational costs, (iv) disciplines dealer quotes for D2C RFQ and bilateral trade requests, and (v) provides opportunities for buyside firms to profit from their own provision of quotes.

25. There is substantial evidence of such buyside interest in the record. For example, in my opening report I cited [REDACTED]

[REDACTED]¹¹ There are numerous other indications of buyside interest in the record, some of which I summarize in the following paragraphs.

26. [REDACTED]¹³

27. In a 2012 internal email, Mike Hisler of Javelin, an entrant provider of an anonymous all-to-all IRS trade platform, wrote: "Alliance Bernstein: want to be customer. They get it. Met with entire trading desk. Love CLOB and their ability to make mkts whenever they want (non DMM)."¹⁴ I understand the "ability to make mkts" to refer to the option available to a buyside firm to act as a market maker by providing liquidity to other market participants.

28. [REDACTED]

¹¹ [REDACTED]

¹² [REDACTED]

¹³ [REDACTED] Dep. Tr. 27:4-27:11, 29:10-29:16, 237:20-238:2.

¹⁴ JAV_00275472.

- [REDACTED]
29. In his deposition in this matter, [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED] 17
30. Even Professor Johannes, when questioned at deposition, admitted that he would expect there to be buy-side interest in AA2A trade. When asked if class members would benefit from having the option to trade on a CLOB, Professor Johannes conceded that “it certainly could be the case that adding new options help some trades.”¹⁸ He admitted that “some customers might want to trade RFQs, some customers might want to trade a CLOB. That’s certainly the case that... some customers might want to do that.”¹⁹
31. Professor Johannes further admitted that “some customers might want in some scenarios to execute on a CLOB,” and identified “a highly informed customer” or a customer who does not “have any good relationships with banks” or “at least for some trades maybe, big trades, small trades, certain types of trades you could get a better execution on a CLOB. That’s certainly possible.”²⁰ Professor Johannes further recognized that it is not a “binary choice” between RFQ and a CLOB and that “market participants use different trading protocols.”²¹
32. Professor Johannes also admitted that his report discusses all-to-all RFQ only in the context of corporate bonds, and that he could not recall without reviewing his report whether his report discusses the possibility that IRS products could be traded via anonymous all-to-all RFQ.²²
33. In my opening report and earlier in this report I provided record evidence indicating the desire of buy-side firms to have access to the anonymity of exchange trading conditions.²³ Simple logic implies that buy-side firms would prefer to have a choice to trade via D2C

¹⁵ [REDACTED]

¹⁶ [REDACTED] Dep. Tr. 313:17-313:23.

¹⁷ [REDACTED] Dep. Tr. 153:10-18.

¹⁸ Johannes Dep. Tr. 367:6-10.

¹⁹ Johannes Dep. Tr. 372:5-10.

²⁰ Johannes Dep. Tr. 374:4-13.

²¹ Johannes Dep. Tr. 73:5-15.

²² Johannes Dep. Tr. 59:2-17, 62:23-63:25.

²³ Duffie Rep. ¶¶106-122.

RFQ whenever this gives them a better price, and otherwise to trade at an AA2A venue. Yet, the Defendants' experts' reports do not acknowledge the benefit of having a menu of alternative trading venues. They focus instead on situations in which a buy-side firm would naturally prefer to place trades on a name-disclosed basis. In reality, wherever an exchange exists, buy-side firms often choose to trade on the exchange rather than OTC in order to lower their execution costs as a quote taker in a competitive market or to earn additional profits as a quote provider. This is the case, obviously, for all existing exchange-traded products, such as equities, futures, and equity options. These buy-side benefits would apply in the but-for world to IRS products available for trade on AA2A venues. For their OTC quote requests, the parallel existence of active anonymous all-to-all trade generates more competitive pricing from dealers. Dealer quotes are disciplined by the price transparency emanating from AA2A trade and by the option to substitute with AA2A trade.

B. Example: The upstairs and downstairs markets for listed equities

34. There is abundant empirical evidence that many buy-side firms trade listed equities in both the "upstairs" (OTC) market and the "downstairs" AA2A (exchange) market. Exchange trading of U.S. equities is active, constituting about 70% of total trade volumes of listed equities.²⁴ This is so despite the fact that exchange trade: (i) fails to exploit customer relationships with dealers, (ii) involves more informed-trader adverse-selection risk for quote providers than OTC trade with identifiably uninformed counterparties, and (iii) has higher price-impact costs than OTC trade for sufficiently large block-size orders.
35. The Defendants' experts rest their case for the lack of viability of exchange trading of IRS primarily on these same three claimed disadvantages of exchange trading. Yet equity exchanges, among many other financial exchanges, are extremely active. These exchanges exist because they offer other advantages, primarily greater competition among quote providers, higher pre-trade and post-trade price transparency, lower access costs, and lower operational costs, as detailed in my opening report.²⁵ Moreover, the existence of active transparent exchanges lowers buy-side off-exchange trading costs. The existence of an exchange does not, moreover, remove the opportunity to trade off the exchange, directly with a dealer.
36. In 1997 research published in a leading peer-reviewed academic finance journal,²⁶ Madhavan and Cheng analyze a representative sample of block trades of Dow-Jones stocks and find that expected price-impact execution costs for orders of more than about 20,000 shares were smaller for upstairs (OTC) trades than for downstairs (exchange

²⁴ Here, by "listed equities," I refer to equities traded in the National Market System. Laura Tuttle, "OTC Trading: Description of Non-ATS OTC Trading in National Market System Stocks," Securities and Exchange Commission, Division of Economic and Risk Analysis, March 2014, https://www.sec.gov/marketstructure/research/otc_trading_march_2014.pdf.

²⁵ Duffie Rep. ¶¶61, 159-186.

²⁶ Ananth Madhavan and Minder Cheng, "In Search of Liquidity: Block Trades in the Upstairs and Downstairs Markets," *Review of Financial Studies*, vol. 10, no. 1 (1997), pp. 175-203.

limit-order-book) trades. For orders below about 20,000 shares, execution costs were smaller in the downstairs (CLOB) market. Buyside firms therefore split their trades across the two venue types based in part on trade size, an example of the valuable option to trade on both types of markets.

37. Off-exchange trading venues for listed equities, including dark pools such as Liquidnet and Posit, further allow buyside firms to execute block trades at the exchange midpoint price, that is, with no bid-offer spread and no price impact costs. This form of trade would not be possible without the price discovery offered by exchanges. While dark-pool execution comes at the cost of some delay, according to Rosenblatt Securities dark pools account for about 15% of U.S. equity trading volume.²⁷ For treasuries, index CDS, and IRS, similar “size-discovery” trading protocols are extremely active and lower execution costs for large block trades, as I will discuss later in this report. These size-discovery venues depend on price discovery that is sourced from limit-order-book markets.
38. As I explained in my opening report, in the but-for world, buyside firms would prefer to execute some or all of their IRS block trading interests away from an anonymous all-to-all venue in order to get better price execution. However, the disciplining effect on dealer quotes of exchange price transparency and the option to substitute with a trade on an anonymous all-to-all venue improves off-exchange execution prices. These principles apply as well to listed equity markets.
39. In research published in 2002 in a leading peer-reviewed academic finance journal, Booth, Lin, Martikainen, and Tse write:

*“We provide empirical evidence on the economic benefits of negotiating trades in the upstairs trading room of brokerage firms relative to the downstairs market. Using Helsinki Stock Exchange data, we find that upstairs trades tend to have lower information content and lower price impacts than downstairs trades. This is consistent with the hypotheses that the upstairs market is better at pricing uninformed liquidity trades and that upstairs brokers can give better prices to their customers if they know the unexpressed demands of other customers. We find that these economic benefits depend on price discovery occurring in the downstairs market.”*²⁸

40. Professor Johannes emphasizes that buyside firms can benefit with a D2C RFQ trade, relative to an exchange trade, if they have sufficiently little information.²⁹ In such a trading situation, a quote provider who is aware of the low degree of information held by a specific buyside firm for a specific trade can offer quotes that reflect a low risk of being

²⁷ “Let There be Light – US Edition,” Market Structure Reports, Rosenblatt Securities, April 25, 2019, <https://www.rblt.com/market-reports/let-there-be-light-us-edition-9>.

²⁸ Geoffrey Booth, Ji-Chai Lin, Teppo Martikainen, and Yiuman Tse, “Trading and Pricing in Upstairs and Downstairs Stock Markets,” *Review of Financial Studies*, vol. 15, no. 4 (2002), pp. 1111–1135.

²⁹ Johannes Rep. ¶¶72-82, 98-105.

adversely selected into the trade at a loss. This principle is well understood and applies with far greater force to the equity market, where privately held information about the performance of equities is a much bigger risk to quote providers than is the case in IRS markets, given that information on major-currency LIBOR, EURIBOR, and risk-free rates is widely and relatively symmetrically held. Does the adverse-selection effect imply that buy-side firms avoid trading on equity exchanges? Obviously not. Just as clearly, buy-side firms get better pricing in their off-exchange trades through the benefit of exchange-sourced price discovery. Professor Johannes is unable to demonstrate a lack of desire of buy-side firms to access anonymous all-to-all trade of equities, much less IRS, where his arguments are considerably weaker.

C. The Defendants' experts' bid-offer spread comparisons are not probative

41. The Defendants' experts rely on bid-offer spread comparisons that suffer from a consistent logical error: they compare D2C RFQ spreads and AA2A spreads without recognizing the price-disciplining impact of the existence of AA2A trade on D2C RFQ spreads. This weakness is highlighted with the following simple hypothetical example. The example is consistent with the form of the numerical comparisons of spreads that the Defendants' experts present. I do not concede the numerical aspects of their comparisons, a different issue to which I will return.
42. Suppose that the bid-offer spread for D2C RFQ buy-side trades of some financial product is 0.2 basis points before the advent of anonymous all-to-all trade. Then, an exchange enters the market. With this entry, suppose that D2C RFQ bid-offer spreads decline to 0.1 basis points because (i) the trade requests that are selected into the D2C RFQ venue are those that will receive lower bid-ask spreads at this venue than on the exchange, (ii) the price transparency emanating from the exchange disciplines dealers' OTC quotes, and (iii) common knowledge of the buy-side option to substitute an OTC trade with an exchange trade disciplines dealer OTC quotes. Suppose that exchange bid-offer spreads turn out to be 50% higher than OTC spreads, at 0.15 basis points, reflecting a selection effect that sends relatively more informed orders to exchanges, and given the inability to exploit client-dealer relationships (if any) on an exchange. Although observed exchange bid-offer spreads are higher in this hypothetical market than D2C RFQ spreads, as the Defendants' experts have argued would be the case, the entire comparison approach is based on false logic.
43. In this hypothetical, every buy-side firm has benefited from the transition to a market with anonymous all-to-all trade. Buy-side firms faced an average bid offer-spread of 0.2 basis points before the exchange entered, and now face a lower average bid-offer spread (a blended average of 0.15 and 0.1 basis points, depending on the mix of venue selections across buy-side trades). In their case examples, the Defendants' experts compare realized D2C RFQ bid-offer spreads with realized exchange bid-offer spreads. Even if their spread comparisons were numerically accurate (which I will dispute), this comparison is not probative to the benefit to buy-side firms of introducing AA2A trade.
44. Similarly, using the CDS index and treasury markets as examples, the Defendants' experts compare D2C RFQ bid-offer spreads with interdealer CLOB bid-offer spreads as

though this apples-to-oranges comparison is probative to the benefits to buy-side firms of trading in the all-to-all market. One should compare instead the total execution costs that would apply in the actual world to total costs in the but-for world.

45. Moreover, the Defendants' experts treat bid-offer spreads as though they are the determinant of trading costs at all-to-all trade venues. However, about 70% of CDS Index trades³⁰ and about half of U.S. treasuries trades³¹ at all-to-all (among dealer) platforms are executed using size-discovery protocols that avoid price impact and bid-offer-spread costs. The implications of size discovery was simply overlooked by Professor Johannes when he made his bid-offer comparisons, as was revealed in his deposition.³² If about half of trade is done by size-discovery, then the effective (price-to-mid-point) cost of trade is about half of that suggested by the bid-offer spread. This correct form of comparison, adjusting for size-discovery trading, is applied in the research of Collin-Dufresne, Junge, and Trolle.³³ This size-discovery adjustment alone is enough to reverse the comparison in their paper. Collin-Dufresne, Junge, and Trolle find that, when incorporating the effect of size-discovery, D2C RFQ transactions costs turn out to be higher than all-to-all (among dealer) transaction costs. Their research shows that a comparison made on the basis of bid-offer spreads alone reaches the opposite and incorrect conclusion as to which venue has lower average trade costs. In any case, as I have emphasized earlier in this paragraph, these comparisons, even if properly adjusted for size discovery, are not probative to the buy-side benefit of the introduction of AA2A trade. What matters is that total buy-side trading costs are reduced by the introduction of AA2A trade, including the effect of the option to pick the cheaper-execution venue after AA2A trade exists.
46. Further, in making such comparisons, one should include the benefits of profits to buy-side firms associated with quote provision, and also the price disciplining benefits for OTC trades of related products that do not trade at anonymous all-to-all venues.
47. In practice, exchange-like trading conditions reduce adverse-selection costs because (i) continually streaming prices cause every market participant to have a fresh up-to-the-moment observation of the going price and (ii) high competition for quote provision drives down bid-ask spreads, which increases the breadth of market participation so as to include somewhat less informed traders, which in turn lowers bid-ask spreads, thus

³⁰ Pierre Collin-Dufresne, Benjamin Junge, and Anders Trolle, "Market Structure and Transaction Costs of Index CDSs," Swiss Finance Institute Research Paper Series No. 18-40, October 29, 2018, forthcoming, *Journal of Finance*, Table 5.

³¹ Michael Fleming and Giang Nguyen, "Order Flow Segmentation and the Role of Dark Trading in the Price Discovery of U.S. Treasury Securities," Federal Reserve Bank of New York Staff Reports, Staff Report No. 624, August 2013.

³² Johannes Dep. Tr. 265:6-16.

³³ Pierre Collin-Dufresne, Benjamin Junge, and Anders Trolle, "Market Structure and Transaction Costs of Index CDSs," Swiss Finance Institute Research Paper Series No. 18-40, October 29, 2018, forthcoming, *Journal of Finance*, Table 5.

drawing in even less informed traders, and so on in a virtuous loop of widening participation and shrinking bid-offer spreads.

48. Professor Johannes' analysis of "spread-to-mids" makes a comparison in the actual world between spreads for RFQ trades and those posted on AA2A platforms.³⁴ He portrays this comparison in a manner suggesting that benchmark IRS have tighter bid-offer spreads on RFQ than they would have at active anonymous all-to-all venues. However, his analysis relies on actual-world data, and does not incorporate but-for compression of bid-offer spreads and the ability to trade inside the bid-offer spread for a large fraction of AA2A trades. This analysis therefore does not imply that these products are ill suited for all-to-all trading.

49. Dr. Culp admits in his deposition testimony that he treated actual world bid-offer spreads as though they would be the same as bid-offer spreads in the but-for world.

"Q. Okay. But you took this data from the actual world as a proxy for what would have happened in a world without that conspiracy, correct?"

A. Sorry. The statement as you put it is correct, this is based on real world data.

Q. And none of this data reflects any anonymous all-to-all trading, correct?"

*A. That's right."*³⁵

50. The actual world of IRS trade, in which bid-offer spreads reflect the impact of the alleged conspiracy on the liquidity provision by dealers to AA2A platforms, is not predictive of the but-for world.

51. Moreover, the Defendants' experts' own assertions about a preference to make less-informed trades "off exchange" implies that a direct comparison of on-exchange and off-exchange bid-offer spreads suffers from a selection bias. This is an apples-to-oranges comparison of trading costs. In the but-for world, buy-side firms retain the option to make less informed trades through D2C RFQ and get cheaper execution for other trades on anonymous all-to-all platforms, with an overall reduction in average trading costs caused by the factors that I have described (superior competition and pre-trade price transparency, disciplining of dealer quotes, profits from buy-side quote provision).

52. Defendants' experts falsely treat execution costs on exchanges as though they are set by the bid-offer spread. In fact, a large fraction of exchange trades occur at prices inside the best bid-offer price interval. For example, the industry white paper "Total Cost Analysis of Interest Rate Swaps v. Futures,"³⁶ Greenwich Associates reports that an average of 41% of buy-side trade in interest rate futures is conducted at the mid-point of the bid-ask

³⁴ Johannes Rep. ¶¶72-80, Exs. B, C, D.

³⁵ Culp Dep. Tr. 333:6-14.

³⁶ Andrew Awad and Kevin McPartland, "Total Cost Analysis of Interest-Rate Swaps vs. Futures," Greenwich Associates, LLC, 2015.

spread. This implies a 41% reduction in the cost of trade implied by the bid-offer spread, a substantial buy-side saving that the Defendants' experts did not consider in their reports. The Defendants' experts put a lot of weight in their reports on the idea that a dealer's best swap customers are given the chance to execute via RFQ at mid-point pricing. Greenwich Associates finds, however, that in order to create similar risk exposures on a hypothetical \$100 million notional trade, Eurodollar futures or treasury futures offer much cheaper execution than swaps obtained via RFQ, at all tenors and holding periods.

53. In research published in 2015, Andros Gregoriou "examine[d] the market liquidity effects of a recent sample of firms that are listed on the FTSE AIM Index before and after they were available on an electronic limit-order trading system. These stocks are of particular interest as they are illiquid stocks with spreads in the range of 5–12% of the share price. Therefore, we are investigating the impact of limit-order trading on the market liquidity of highly illiquid stocks... Our findings show a significant increase in the liquidity of the stocks after the introduction of electronic limit-order trading... Our empirical estimates, obtained from the Madhavan, Richardson, and Roomans (1997) bid-ask spread decomposition model, show a significant decline in the direct cost of trading and no significant change in the asymmetric information cost of trading from the pre to post limit-order trading period. Our empirical findings suggest that computerized limit-order trading systems do enhance liquidity of illiquid stocks, contrary to previous research. This implies that the increased competition induced by electronic trading systems improves the quality of the market for highly illiquid stocks."³⁷
54. Bid-ask spreads at D2C RFQ venues for IRS products tightened significantly over the years 2013-2017, as recognized in Dr. Culp's report. This significant compression in bid-offer spreads for USD IRS was caused by improvement in competition and post-trade price transparency associated with regulation-mandated SEF trade. Because the change in trade protocols was caused by legislation, the imposition of MAT SEF rules constitutes a natural experiment regarding the impact on bid-offer spreads of improving price transparency and competition for quote provision. All-to-all anonymous trade generates even greater price transparency and competition for quote provision than that associated with D2C RFQs, as I explain in detail in my original report.
55. Even after the advent of MAT SEF rules, as Dr. Culp's report states, "[REDACTED]
[REDACTED]
[REDACTED]"³⁸ This reduction in buy-side trading costs at RFQ venues was not caused by changes in customer-dealer relationships or changes in the degree to which buy-side firms were privately informed about interest rate changes. There is little privately held information about general market interest rates, and in any case there was no significant change over time in the quality of information held by buy-side firms that conducted their trades on these RFQ platforms. During this period, however, there was increased competition for quote provision on these platforms, caused by the

³⁷ Andros Gregoriou, "Market Quality of Dealer Versus Hybrid Markets for Illiquid Securities: New Evidence from the FTSE AIM Index," *European Journal of Finance*, vol. 21, no. 6 (2015), pp. 467-468.

³⁸ Culp Rep. ¶287.

entry of non-bank-affiliated (non-defendant) dealers, particularly Citadel. As I explained in my opening report, increased competition for quote provision tightens bid-offer spreads. This is not controversial.

56. Professor Johannes also states that “mandatory RFQs increase competition, forcing simultaneous dealer competition, and reducing transactions costs.”³⁹ In his deposition in this matter, Professor Johannes admitted that in the actual world, [REDACTED]⁴⁰
57. In the but-for world, IRS bid-offer spreads would have declined to an even greater extent, and much earlier, because anonymous all-to-all trade generates inherently greater competition for quote provision than D2C RFQ trade. Professor Johannes suggests instead that mandatory RFQ creates as much competition for trades as anonymous all-to-all trade.⁴¹ That claim is not consistent with the definition and economic basis of competition: More bidders implies more competition. This effect is abundantly clear in the corporate bond market from the empirical results of Hendershott and Madhavan,⁴² cited by Professor Johannes, which show a strong reduction in buy-side transactions costs as the number of quote providers increases.
58. The impact of the entry of Citadel clarifies this issue. For example, a January 2016 report published by the financial-industry news service Risk.net stated:

“[Citadel] is the first outsider to break into this bread-and-butter swaps business, and – more importantly – it has changed the way others play the game. ‘Citadel has improved the market structure, in terms of people quoting sharp prices and coming back faster. It’s really forced the dealers to move – I really like that aspect. Even when they don’t win, they’ve done a good service to the industry, making sure others compete on the same terms,’” says a senior trader at one large US asset manager.”⁴³

59. An even starker comparison can be made by comparing pre-SEF market competition and post-SEF competition. It is not controversial – experts agree and academic research confirms – that after USD IRS products were made available for trade on SEFs under the Dodd-Frank Act, bid-offer spreads for these products declined significantly. Quotes from at least three dealers per request, post-SEF, caused more competition than quotes from

³⁹ Johannes Rep. ¶205.

⁴⁰ Johannes Dep. Tr. 46:11-47:10. He later reiterated that “[REDACTED]” Johannes Dep. Tr. 355:22-356:16.

⁴¹ Johannes Rep. ¶206.

⁴² Terrence Hendershott and Ananth Madhavan, “Click or Call? Auction versus Search in the Over-the-Counter Market,” *Journal of Finance*, vol. 70, no. 1 (2015), pp. 441-443.

⁴³ “Interest rate derivatives house of the year: Citadel Securities: Swaps market outsider changes the way the game is played,” Risk.net, January 27, 2016.

one dealer per request, pre-SEF. This is supported, for example, in Bank of England research that is now forthcoming in a peer-reviewed academic journal⁴⁴ and also by the Defendants' expert Dr. Culp, who writes that "bid-ask spreads on USD-denominated IRS generally declined after the imposition of the CFTC MAT Rule" and states that his "Exhibit V-2 illustrates this trend for 10-year USD denominated fixed/float IRS, which have generally declined since the implementation of the MAT Rule."⁴⁵ Dr. Culp's Exhibit V-2 is reproduced below for the reader's convenience. In a footnote, Culp adds: "The trend is similar for other actively traded USD-denominated fixed/float IRS with benchmark tenors."⁴⁶

60. Clearly, as shown in Dr. Culp's Exhibit V-2, competition among quote providers does compress spreads. Further increases in competition for quote provision in the but-for world of active anonymous all-to-all trade would have further lowered bid-offer spreads and buy-side trading costs, and would have acted much more rapidly than was possible in the actual-world D2C RFQ market.
61. Dr. Culp contrasts the post-SEF reduction in bid-offer spreads for US dollar IRS with the case of euro-denominated IRS, whose liquidity suffered from the bifurcation of the EUR IRS market caused by differences in US and EU regulation. I agree with Dr. Culp that the adverse liquidity impact of this bifurcation of the EUR swap market was induced by regulatory differences. This is unrelated to the costs and benefits of introducing a more competitive trade protocol.

D. No sign of a buy-side firm that was harmed, in net, by "orphaned" products

62. The Defendants' experts raise a concern that AA2A trade might have been so popular in the but-for world that it would curtail dealer liquidity for "orphaned" types of products that are not available on AA2A and that could not reasonably be substituted with AA2A trades.⁴⁷
63. From this, the Defendants' experts conjecture that some class members would have been made worse off by the availability of AA2A trade. For this to be true, it would need to be the case that (i) the volumes in the orphaned product are reduced to the point that dealers cut their provision of liquidity to these products, despite the overall increase in market activity induced by AA2A trade, and yet (ii) these inactively traded or customized products form such a large fraction of the trades of the affected class member that the total costs associated with the "orphaning" of these products are larger than the total increased benefits to the affected class member of the reduced trading costs of trade in

⁴⁴ Evangelos Benos, Richard Payne, and Michalis Vasios, "Centralized Trading, Transparency, and Interest Rate Swap Market Liquidity: Evidence from the Implementation of the Dodd-Frank Act," Bank of England Working Paper, 2019, forthcoming, *Journal of Financial and Quantitative Analysis*.

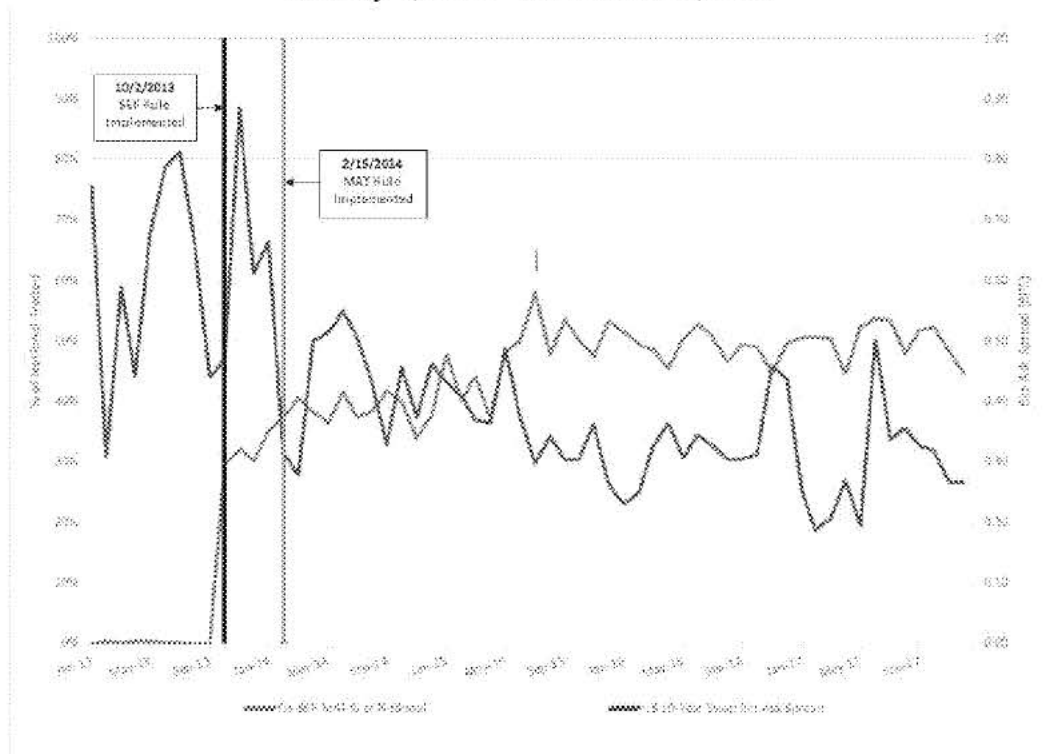
⁴⁵ Culp Rep. ¶294.

⁴⁶ Culp Rep. fn 262.

⁴⁷ Johannes Rep. Section VIII; Culp Rep. Section V, Opp. at 61.

the but-for world for other IRS products. This hypothetical combination is highly unlikely.

Exhibit V-2 of the report of Dr. Christopher Culp, dated June 18, 2019
 Bid-Ask spreads of USD fixed/float IRS executed on U.S. SEFs
 January 1, 2014 – December 31, 2017



SOURCES: Bloomberg, Clarus SDRView. NOTES: Total Volume is all notional volume (cleared or uncleared, on- and off-SEF) trade in USD-denominated fixed/float Swaps over the time period. For this analysis I only consider transactions on U.S. trading days, which excludes weekends and U.S. holidays (as defined by the Federal Reserve), and I exclude compression and list transactions.

64. I have not been able to identify a single class member or type of class member that could have been adversely affected, in net, by this (i)-(ii) combination. The Defendants' experts have also not proposed any such class member or specific type of class member. The adverse effect, if any, for orphaned products, would be outweighed by the success of liquid high-volume trade on anonymous all-to-all venues and resulting buy-side gains.

E. Adverse selection does not override buy-side benefits of AA2A IRS trade

65. Professor Johannes argues that in the but-for world many class members would get "worse prices" on AA2A platforms because adverse selection would widen bid-offer spreads.⁴⁸

⁴⁸ Johannes Rep. ¶¶61, 98-105.

66. Contrary to the assertions of the Defendants' experts⁴⁹ concerning the adverse selection costs to buy-side firms, information regarding U.S. interest rates is widely disseminated. Very little such information is held privately.
67. With respect to information about U.S. interest rates, IRS have about the same scope for private information as US treasuries. (The Defendants' experts make direct comparisons between IRS trading costs and treasuries trading costs.) The authors of a recent New York Fed empirical study of the microstructure of US treasury markets find strong evidence that quote providers for treasuries do not suffer from inferior information. They "show that limit order activities affect prices, and in fact contribute more to the variance of efficient price updates than trades, given limit orders' much higher intensity and variation as compared to trades. The evidence that limit orders also contain value-relevant information suggests that, contrary to the conventional assumption that traders with better information are liquidity demanders (i.e. trade immediately via aggressive orders), they also use limit orders in their trading strategies."⁵⁰
68. IRS have far less scope for private information and adverse selection than equities, yet equities are actively traded OTC and on exchanges. The existence of adverse selection does not imply a lack of participation by buy-side firms at AA2A platforms, where they would benefit from compressed spreads.
69. Adverse selection is not severe enough to stop quote provision on D2D CLOBs, and would be even less severe in the but-for world because of the increased presence on CLOBs of less informed quote requesters.

F. Customer relationship pricing does not override AA2A benefits

70. Professor Johannes relies on the idea that customer relationships are beneficial to some dealer clients, who can take advantage of this by identifying themselves to dealers with OTC requests for quotes.⁵¹ Even if this were the case, I disagree that this implies harm to any buy-side firm caused by augmenting the market with active anonymous all-to-all trade. To the contrary, augmenting the market structure with additional options would have led to significant benefits for all or nearly all buy-side firms, for the reasons I have described. Moreover, I will provide an abundance of evidence in this section that customer-dealer relationship effects do not offer significant benefits to buy-side firms even in the actual world. Relationships would be of even less benefit in the but-for world, because of the lower costs, in many situations, of anonymous all-to-all trade.
71. In OTC markets, a history of close relationship between a dealer and a customer need not improve the prices received by a customer. For example, my research with Adam

⁴⁹ Johannes Rep. ¶¶98-105, Appendix 12; Culp Rep. ¶229.

⁵⁰ Michael Fleming, Bruce Mizrach, and Giang Ngyuen, "The Microstructure of a U.S. Treasury ECN: The BrokerTec Platform," *Journal of Financial Markets*, vol. 40 (2018), pp. 2-22.

⁵¹ Johannes Rep. ¶¶95-96, Exs. F-H.

Ashcraft of the New York Fed on the pricing achieved by customers of the largest dealers in the OTC market for federal funds⁵² shows that a history of repeated trade by the customer with the same dealer significantly *worsens* the price obtained by the customer. This finding is supported by a New York Fed 2014 research paper by Afonso, Kovner, and Schoar,⁵³ which finds statistically significant adverse effects of frequent trade relationships.

72. If a “loyal” customer has traded with relatively few dealers in the past, then a dealer with whom the customer has a frequent trade relationship has a greater incentive to take advantage of the customer because the dealer may infer that the customer is not shopping aggressively among other dealers. This is in line with standard industrial-organization models of imperfect competition based on “sticky” customers with relatively high search or supplier-switching costs.⁵⁴ There is abundant empirical evidence in peer-reviewed academic research⁵⁵ of the cost to customers of demonstrating loyalty to their suppliers.

73. It would be costly on any given IRS trade for a customer to select a dealer based on “relationship” over price. Competition among dealers is to the advantage of buy-side firms, especially for sophisticated large institutional IRS market participants.

- 74.
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED]
- [REDACTED] b7
- [REDACTED]

⁵² Chapter 2 of *Dark Markets: Asset Pricing and Information Transmission in Over-the-Counter Markets*, Princeton University Press, 2012 and “Systemic Illiquidity in the Federal Funds Market” (with Adam Ashcraft), *American Economic Review, Papers and Proceedings*, vol. 97, no. 2 (2007), pp. 221-225.

⁵³ Gara Afonso, Anna Kovner, and Antoinette Schoar, “Trading Partners in the Interbank Lending Market,” Federal Reserve Bank of New York Staff Report No. 620, May 2013 Revised October 2014, https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr620.pdf.

⁵⁴ Steven Salop, "The Noisy Monopolist: Imperfect Information, Price Dispersion and Price Discrimination," *The Review of Economic Studies*, vol. 44, no. 3 (1977), pp. 393-406.

⁵⁵ Examples include: Lakshman Krishnamurthi and S. P. Raj, "An Empirical Analysis of the Relationship Between Brand Loyalty and Consumer Price Elasticity," *Marketing Science*, vol. 10, no. 2 (1991), pp. 172-183; Edward Ramirez and Ronald E. Goldsmith, "Some Antecedents of Price Sensitivity," *Journal of Marketing Theory and Practice*, vol. 17 (2009), pp. 199-214; Michael A. Jones, David L. Mothersbaugh, and Sharon E. Beatty, "Why Customers Stay: Measuring the Underlying Dimensions of Services Switching Costs and Managing their Differential Strategic Outcomes," *Journal of Business Research*, vol. 55 (2002), pp. 441-450; Oz Shy, "A Quick and Easy Method for Estimating Switching Costs," *International Journal of Industrial Organization*, vol. 20 (2002), pp. 71-87.

⁵⁶ [REDACTED] Dep. Tr. 54:11-13.

⁵⁷ [REDACTED] Dep. Tr. 54:16.

75. Even if the Defendants' experts were correct that there are conditions under which a dealer might give a "favored" customer better bid-offer spreads on certain types of trades, this would not imply that the customer is better off in the actual world than in the but-for world. While a more favored customer might be getting better prices than a less favored customer, this does not imply that any of the customers are getting a good deal. All of the customers could in principle get better pricing if they were able to trade "at dealer cost," that is, to mitigate dealer markups by trading in the same market in which dealers trade with other dealers. This is possible if there is an anonymous all-to-all market.
76. As another example, empirical research on the corporate bond market by DiMaggio, Kermani, and Song⁵⁸ shows that more frequent counterparties of a core dealer get better prices than less frequent counterparties. The authors also show, however, that counterparties that are not core dealers get significantly worse prices from core dealers than do counterparties that are core dealers. The average price markup that customers pay to dealers in the corporate bond is shown to be large, approximately 50 basis points higher than the average markup that dealers pay to dealers.
77. In any case, with the transition to the but-for world of IRS trade, all customers, both more and less favored, would get better quotes from dealers because the customers have better price transparency and have the option to substitute with AA2A trade if the dealer's quotes are not good enough.
78. Dr. Culp nevertheless argues that the benefits received by buy-side investors from pre-trade name disclosure are so great as to outweigh the advantages received from AA2A trading:

*"Many buy-side customers derive benefits from the relationships they have developed with their dealer counterparties that would be lost if they executed their trades in an anonymous trading environment. The value of such relationships is well-documented in the academic literature and industry publications and outweighs whatever advantages are offered by AA2A trading for many buy-side customers."*⁵⁹

79. Among the sources cited by Dr. Culp for customer relationship benefits is a research paper on the CDS market by Riggs, Onur, Reiffen, and Zhu.⁶⁰ This research actually shows no significant correlation between customer-dealer relationship and quoted price. Although the point estimate for the effect of customer-dealer relationship on bid-offer spread is negative, the effect of relationship is not statistically significantly different from zero at traditional confidence levels used in academic research. The authors' results do

⁵⁸ Marco Di Maggio, Amir Kermani, and Zhaogang Song, "The Value of Trading Relations in Turbulent Times," *Journal of Financial Economics*, vol. 124 (2017), pp. 266-284.

⁵⁹ Culp Rep. ¶343.

⁶⁰ Lynn Riggs, Esen Onur, David Reiffen, and Haoxiang Zhu, "Swap Trading after Dodd-Frank: Evidence from Index CDS," August 17, 2019, forthcoming, *Journal of Financial Economics*.

show that a more frequent trading relationship is linked to a higher likelihood that a dealer will respond to a customer's quote request, but that supposed benefit to the customer could be related to other effects. For example, a dealer might respond with higher likelihood because the customer is known to accept quotes that are more profitable for the dealer.

80. In his discussion of claimed buy-side relationship benefits, Dr. Culp cites a 2016 research paper on the triparty repo market by Han and Nikolaou. These authors, however, actually find as follows: "While maintaining trading with a broad set of counterparties, trade parties tend to allocate greater amount of volumes to some 'preferred' ones. In addition, 'preferred' counterparties and relationships are stable over time, in that relationship formation depends positively on their previous dependence in the same market."⁶¹ However, the authors also find "that a greater relationship strength leads to less bargaining power over the rate, as the [money market mutual funds] with higher dependence on a given dealer may accept a marginally lower rate on their investment, while dealers with higher dependence on [money market mutual funds] may need to pay higher funding costs."⁶²
81. This research by Han and Nikolaou thus adds to the empirical evidence that I provided earlier, which is supported by economic principles, that a customer gets worse prices from a dealer with whom it has demonstrated a loyal relationship.

G. AA2A venues discipline dealer pricing in other trade venues

82. In my opening report, I explained that for the four classes of standardized IRS products at issue in this matter, trades that are not executed on AA2A platforms would benefit in the but-for world from the effects of price disciplining of dealer quotes. In the but-for world, anonymous all-to-all trade of the four types of plain-vanilla IRS products at issue would have disciplined dealers' bid-offer spreads for similar types of IRS products that were not sufficiently actively traded to migrate to anonymous all-to-all trade platforms. This price disciplining, caused by exchange price transparency and the option to substitute with AA2A-traded products, would have reduced the costs of trading non-benchmark IRS products whose trade would have remained off AA2A venues.
83. Price disciplining is more powerful to the degree that the product not available on AA2A venues has a closer substitute which is traded at an AA2A venue. This is so because the "exchange price" of Product A is a better guide to the fair price of Product B to the extent that A and B are related. Moreover, the option to substitute Product A for Product B is a greater discipline on the dealer pricing of Product B to the extent that A and B are more closely related. As I explained in my opening report, these price transparency and substitution effects are not limited to a comparison with a single exchange product. Essentially the same disciplining effect applies if Product B is relatively close in risk

⁶¹ Song Han and Kleopatra Nikolaou, "Trading Relationships in the OTC Market for Secured Claims: Evidence from Triparty Repos," *FEDS Working Paper* No. 2016-064 (2016), p. 2.

⁶² Song Han and Kleopatra Nikolaou, "Trading Relationships in the OTC Market for Secured Claims: Evidence from Triparty Repos," *FEDS Working Paper* No. 2016-064 (2016), p. 21.

characteristics to some portfolio of actively traded AA2A products, A1, A2, A3, and so on. Given the four classes of IRS products at issue (plain-vanilla IRS, FRAs, OIS, and single-currency basis swaps), there would be relatively high achievable substitution between IRS products traded off AA2A platforms and portfolios of IRS products traded on AA2A platforms, considering the relatively high degree of standardization and product homogeneity within these four product classes.

84. The Defendant dealers were aware of the threat of substitution. For example, a May 2012 Citi analyst report wrote that, “Central limit order books are likely to have much tighter bid/asks especially for the smallest trades, which we expect will exert downward pressure on the pricing of all swaps across all platforms.”⁶³
85. The price-discipline impact of AA2A trade is also borne out in empirical examples.
86. For example, in the German government bond market, price discovery and liquidity are generated primarily from anonymous all-to-all trade in the exchange market for bund futures on Eurex. According to the German federal government debt management bureau,

*“Besides ensuring that German Government securities can be traded at any time, it is equally important that buy and sell orders can be executed at fair market prices. In this respect, there are no other fixed income securities on the European capital market whose price quality is comparable to that of German Government securities. This high liquidity is primarily due to the futures contracts traded on the German futures & options exchange “Eurex” whose pricing is oriented to German Government securities, which are the only securities accepted for delivery. 2-, 5-, 10- and 30-year German Government securities serve as the underlyings for these futures contracts. The main turnover on the futures market is in the contract for the ten-year Bund future in which more than 202 mn [million] contracts and a volume of more than € 32 tn [trillion] (market value) were traded in 2018. Accordingly, the 10-year Federal bond, which serves as this future's underlying, also accounts for the lion's share of the turnover in the international secondary market for German Government securities.”*⁶⁴

87. The German government debt management office reports that the average volume of trade in German government securities handled by major dealers in the over-the-counter market is approximately 19 billion euros per day in 2018.⁶⁵ By comparison, average

⁶³ JPMC-IRS-00080642, p. 110.

⁶⁴ “Secondary Market,” Federal Republic of Germany Finance Agency, 2019, <https://www.deutsche-finanzagentur.de/en/institutional-investors/secondary-market/>.

⁶⁵ “Secondary Market,” Federal Republic of Germany Finance Agency, 2019, <https://www.deutsche-finanzagentur.de/en/institutional-investors/secondary-market/>.

volume of trade in German government securities exchange-traded futures contracts has been running at over 150 billion euros per day.⁶⁶

88. Recent academic research by Thorsten Martin⁶⁷ shows the impact of price discipline associated with the introduction of anonymous all-to-all trade of steel futures on producer markups in the over-the-counter steel market. Futures trading was introduced in 2008 by London Metals Exchange, followed within a few months by New York Mercantile Exchange. Martin writes: “In the empirical setting, when steel futures are introduced, steel customers can use the information contained in the futures prices in their decision whether to buy from a given steel producer or to search for a better offer.[fn omitted]”⁶⁸ Martin finds, citing the predictions of my research with Dworczak and Zhu,⁶⁹ that “Price transparency increases customers’ incentives to enter the market... while quantities sold increase by 10 percent, producer profits (normalized by 2002 assets) drop by 3 percentage points. These results are in line with the anecdotal evidence: Market observers expected producers to suffer from the introduction and steel producers strongly resisted the introduction of the futures market.”
89. Professor Martin states that his empirical results support the impact of price transparency on dealer pricing modeled in Janssen, Pichler, and Weidenholzer (2011)⁷⁰ and in my research with Dworczak and Zhu. He writes: “In line with the theory, I find that treated producer profit margins drop by 4 to 5 percentage points relative to control steel producers right after the introduction of steel futures.”

⁶⁶ According to Eurex, daily futures in August 2019 averaged, in notional (euros), about 45 billion in Bobl futures, 71 billion in bund futures, 8 billion in long-term bond (Buxl) futures, and 33 billion in Schatz futures, for a total of about 157 billion per day. Eurex Monthly Statistics, Eurex, August 2019, p. 113, https://www.eurexchange.com/resource/blob/1621236/866efbb83183353f95efa51422261a9e/data/monthlystat_201908.pdf, where average daily notional is equal to [(total contracts traded in the month * €100,000 per contract) / trading days in the month]. For example, bund futures (15,566,214 * €100,000) / 22 trading days in August = €71 billion.

⁶⁷ Thorsten Martin, “Real Effects of Price Transparency: Evidence from Steel Futures,” Working Paper, Bocconi University, June 3, 2019, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3299384.

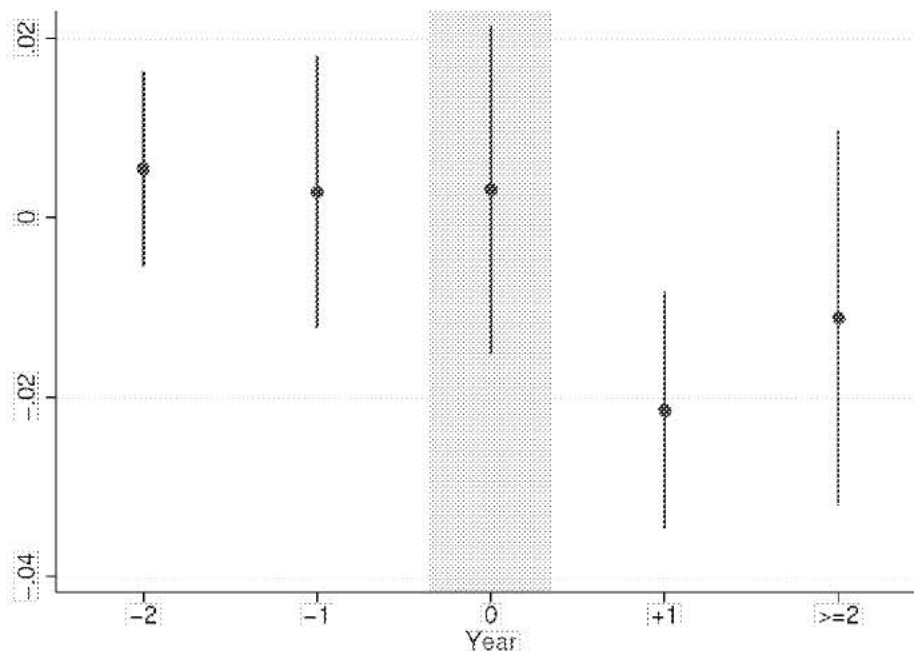
⁶⁸ Thorsten Martin, “Real Effects of Price Transparency: Evidence from Steel Futures,” Working Paper, Bocconi University, June 3, 2019, p. 3, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3299384.

⁶⁹ Thorsten Martin, “Real Effects of Price Transparency: Evidence from Steel Futures,” Working Paper, Bocconi University, June 3, 2019, p. 3, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3299384 referencing Darrell Duffie, Piotr Dworczak, and Haoxiang Zhu, “Benchmarks in Search Markets,” *Journal of Finance*, vol. 72, no. 5 (2017), pp. 1983-2044.

⁷⁰ Thorsten Martin, “Real Effects of Price Transparency: Evidence from Steel Futures,” Working Paper, Bocconi University, June 3, 2019, pp. 2-3, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3299384, referencing Maarten Janssen, Paul Pichler, and Simon Weidenholzer, “Oligopolistic Markets with Sequential Search and Production Cost Uncertainty,” *RAND Journal of Economics*, vol. 42, no. 3 (2011), pp. 444-470 and Darrell Duffie, Piotr Dworczak, and Haoxiang Zhu, “Benchmarks in Search Markets,” *Journal of Finance*, vol. 72, no. 5 (2017), pp. 1983-2044.

90. Figure 1, reproduced from Figure 3 of Martin (2019), shows the impact of the introduction of futures exchange price transparency, which occurred at the point marked “Year 0” in the figure, on estimated reductions in customer purchase costs. The reduction in customer purchase costs is economically large and statistically significant. Professor Martin’s analysis also shows a substantial reduction in estimated dealer markups.

Figure 1. Estimated impact on customer cost for steel of the introduction of exchange trade of steel futures contracts on LME and NYMEX in 2008. A decline of 0.01 corresponds to a reduction in customer costs⁷¹ of approximately 1%. Source: Martin (2019).



91. Martin also finds, as discussed in my opening report⁷² and as predicted in my research with Dworczak and Zhu, that the increase in price transparency caused by the introduction of AA2A trade of steel futures significantly improved the ability of customers to identify the lowest-cost producers, generating a further source of price

⁷¹ The caption of Martin’s figure reads: “This figure plots the dynamics of the effect for customer material costs. The blue dots show point estimates obtained by regressing the log of customer material costs on the fraction of treated steel inputs out of total steel used, Future-Steel, interacted with dummies for the years around the introduction. The LME introduced steel futures contracts in Q2 2008, the NYMEX in Q4 2008. Controls include an industry’s beta with respect to GDP and construction sector employment, the fraction of steel material out of total materials used, Steel-Material, capital-to-labor ratio, share of production workers, and sales-growth over the past 10 years, interacted with the Post dummy. The blue lines represent the 90% confidence intervals.”

⁷² Duffie Rep. ¶¶176-177.

improvement to the customers.⁷³ The same principle would apply to the IRS market, because different dealers have different costs for funding and for use of balance-sheet space under post-crisis regulations for large banks.⁷⁴

92. The impact of price discipline associated with the introduction of exchange trade of steel futures was clearly understood inside the steel market. On industry observer wrote:

“The steel industry has again and again voiced its opposition to futures [...] ‘It’s the traditional issue of where you are in the supply chain,’ he said. ‘The major mills have a dominance in pricing in the current system, and they’re happy not to introduce any new means of price discovery.’ But that’s not specific to the steel industry. In almost every case in the last 30 to 40 years established players have generally resisted new contracts.”⁷⁵

93. A *Wall Street Journal* report noted: “But large U.S. and European steelmakers, leery of market speculators and a loss of control over pricing, have been hesitant to make the jump to futures.”⁷⁶
94. Dr. Culp’s report refers to the price-discipline effects described in my opening report as “spread propagation.” Before reading Dr. Culp’s report, I was unfamiliar with the term “spread propagation.” To my knowledge, this term is not used in the relevant academic literature. The price-discipline effects described in my report are not indirect second-order effects. Price-discipline benefits to buy-side firms are the direct consequence of AA2A trade.

95. [REDACTED]

⁷³ At page 4, Martin writes: “To identify low-cost producers, I exploit that steel is made either from iron ore, using basic oxygen furnaces (BOF), or from steel scrap, using electric arc furnaces (EAF). The relative cost advantage of the two production technologies depends on the prices of iron ore and scrap. Theory predicts that increased price transparency makes market shares more responsive to the relative cost advantage of the two production technologies. I find that after the introduction of steel futures, the market share of treated electric arc producers increases by 0.2 percentage points more when the ratio of iron ore to scrap prices increases by one standard deviation (18 percentage points), relative to control producers.”

⁷⁴ Leif Andersen, Darrell Duffie, and Yang Song, “Funding Value Adjustments,” *Journal of Finance*, vol. 74, no. 1 (2019), pp. 145-192.

⁷⁵ Michael Cowden, “Credit Squeeze May Help Steel Futures Launch,” *American Metal Market*, October 17, 2008, <https://globalfactivacom.ezproxy.hec.fr/ga/default.aspx>.

⁷⁶ Matt Day, “Steel Users Seek Futures,” *Wall Street Journal*, September 21, 2011.

[REDACTED]

[REDACTED]

96.

[REDACTED]

97. In his deposition, Professor Johannes admitted that, absent the alleged conspiracy, it is “certainly... possible” that “some trades for certain customers... would have been price

improved.”⁷⁷ Professor Johannes also acknowledged that the Khan study that he cited found “some evidence that the broker interdealer market and dealer-to-customer markets are linked,” meaning that “changes in one market could affect changes or affect the other market.”⁷⁸ He admitted that it “could be the case” that transparency in pricing in one market impacts the pricing in the other market.⁷⁹ In paragraphs 180 and 181 below, I point to the fact that the Khan study does not even present results on customer-to-dealer pricing.

H. Price discipline on dealer quotes is induced by the option to substitute

98. In my opening report, I explained that the emergence of AA2A trade provides buy-side firms with the option to substitute D2C RFQ or other OTC trades with AA2A trades, and that this substitution option induces dealers to provide their customers with more attractive prices even for IRS products that are not available on AA2A venues. I have reviewed Dr. Culp’s arguments in response and do not find them persuasive.
99. First, Dr. Culp argues that substitution is unlikely to be attractive due to basis risk.⁸⁰ Basis risk signals that two products are not identical – it does not rule out substitution. Ford and Chevrolet pickup trucks are not the same, but when setting prices, Ford dealers are disciplined by the presence of Chevy dealers in the same town. Substitution works in the same way in the IRS market, despite the existence of basis risk. When faced with sufficiently wide bid-offer spreads quoted by dealers, investors are known to substitute with related exchange-traded products, even if the exchange-traded product is not a perfect risk substitute.
100. Product substitution would be even more likely in the but-for world. As I explained at my deposition, in the but-for world a wide range of IRS products would be available for AA2A trade in relatively short order. Buy-side firms would thus frequently be able to conduct AA2A trade of IRS products that have risk characteristics suitable for hedging or synthesizing a given position.
101. Discovery in this case supports my opinion. [REDACTED]

⁷⁷ Johannes Dep. Tr. 362:15-19.

⁷⁸ Johannes Dep. Tr. 314:12-315:8.

⁷⁹ Johannes Dep. Tr. 316:4-10.

⁸⁰ Culp Rep. ¶¶206, 210-222.

81

82

102. Recent empirical evidence also confirms that basis risk does not prevent product substitution. For example, a 2018 CFTC empirical study⁸³ based on the new TRACE treasury transactions database finds that “as volatility increases, % DV01 volume [a risk-adjusted measure of volume] migrates from relatively less liquid cash securities to relatively more liquid futures contracts.” That is, when volatility raises dealer costs for absorbing trades, it becomes cheaper to trade on the exchange, so cash-security treasuries trades are substituted with futures trades.
103. The same CFTC study finds that, on average across days, the total risk-adjusted volumes of OTC cash treasuries and CME treasury futures are comparable, but that traders move back and forth between these markets based on their relative liquidity. The authors write: “The analysis here shows that in the liquidity-challenged environments of high volatility or relatively quiet trading hours, traders put on and take off more risk in futures and less in cash. By contrast, when liquidity is relatively plentiful, traders have the luxury of being particular with respect to the exact instruments through which to move risk.”⁸⁴ Here, by “exact instruments,” the authors are referring to specific cash treasury instruments. The authors of the CFTC thus find that traders are willing to suffer basis risk whenever it is sufficiently cheaper to source liquidity in the futures market than in the cash market.
104. Further, Dr. Culp incorrectly argues that the existence of a “clearing basis” is evidence of an inability of buy-side firms in the but-for world to take advantage of the option to substitute D2C RFQ trades with AA2A trades.⁸⁵ Dr. Culp is correct that a significant clearing basis has been caused by a cross-country regulatory bifurcation of the market, which prevents buy-side investors in one jurisdiction from trading in another jurisdiction. This happens because regulators have in some cases failed to give official recognition to

⁸¹ [REDACTED], at ‘654 [REDACTED]

⁸² [REDACTED], at ‘103 [REDACTED]

⁸³ Lee Baker, Lihong McPhail, and Bruce Tuckman, “The Liquidity Hierarchy in the U.S. Treasury Market: Summary Statistics from CBOT Futures and TRACE Bond Data,” Office of the Chief Economist, Commodities Futures Trading Commission, December 3, 2018, p. 5.

⁸⁴ Lee Baker, Lihong McPhail, and Bruce Tuckman, “The Liquidity Hierarchy in the U.S. Treasury Market: Summary Statistics from CBOT Futures and TRACE Bond Data,” Office of the Chief Economist, Commodities Futures Trading Commission, December 3, 2018, p. 6.

⁸⁵ Culp Rep. ¶298.

foreign central counterparties (CCPs), sometimes called “clearing houses,” thus preventing domestic buy-side firms from accessing IRS cleared in foreign CCPs. Dr. Culp mistakenly suggests that the existence of a clearing basis, caused by a regulatory fragmentation of the IRS market between two different jurisdictions, somehow implies that buy-side firms would not be in a position to take advantage in the but-for world of the price-disciplining effect of arbitrage between quotes offered to them by dealers at RFQ platforms and prices available on anonymous all-to-all platforms in the same jurisdiction. Dr. Culp’s use of the clearing basis as an example to make this argument is not logically correct. There is no regulatory or other institutional barriers that would prevent large buy-side firms from executing trades using both D2C RFQ protocols and AA2A protocols *in the same jurisdiction*, other than the alleged conspiracy of the dealers.

I. Disclosing one’s identity to dealers does not reduce information leakage

105. Buy-side firms generally wish to minimize any leakage of information regarding their intended trading strategies. I explain in my opening report⁸⁶ why the avoidance of information leakage makes AA2A anonymity valuable to buy-side firms, and why buy-side firms were turned off by the practice of name give-up at IRS all-to-all venues. Anonymous all-to-all trade allows a buy-side firm to avoid the disclosure of its identity to anyone. D2C RFQ trade, on the other hand, gives up one’s identity to the dealer and discloses the customer’s trading interest to all of the dealers from whom it requests quotes, with attendant costs that I discuss in this section.
106. Professor Johannes asserts that trading at an AA2A venue is disadvantageous to buy-side firms because, despite the associated anonymity, AA2A orders are revealed to all market participants. He writes:

“There are sizeable costs of all-to-all trading which arise precisely from the public disclosure of orders to the entire marketplace. Because of these costs, customers generally avoid broadcasting their IRS orders across the entire market and instead tend to limit their request for quotes to a handful of dealers—behavior inconsistent with a preference for all-to-all trading. Placing an order through all-to-all trading platforms, whether by placing a limit order on a CLOB or via an ‘RFQ-to-all’ eligible counterparties, advertises a customer’s trading intentions to the entire marketplace. This order exposure has long been known to entail significant costs including the potential for wider bid-ask spreads and worse trade execution, especially for large trades. First, issuing an RFQ to a large number of dealers of posting orders on an all-to-all platform advertises a willingness to trade in a certain direction. Other market participants may attempt to front-run and/or offer a worse price, especially if they view the order as indicative of a

⁸⁶ Duffie Rep. Section III.F., ¶¶106-122, 141.

potential shift in the market. This can lead to wider bid-ask spreads and worse execution for the original order.”⁸⁷

107. It is not generally true that the entire book of limit orders is observable to market participants. Large orders can be hidden on many exchanges, whenever that is viewed to be a disclosure concern, by using an “iceberg” order,⁸⁸ which is a limit order whose size is not disclosed to others viewing the order book. trueEX supported iceberg functionality on its IRS CLOB.⁸⁹ Information leakage for large block-trade interests can also be mitigated by shredding a block interest into many small orders that can be executed at multiple times, through multiple trade platforms, and submitted through multiple brokers. In any case, the option to trade some or all of an order by D2C RFQ does not disappear in the but-for world, so the existence of AA2A venues merely adds to the array of approaches for mitigating the disclosure of trading interests. The concern raised by Professor Johannes applies to any financial market, yet many markets have active AA2A trade venues.
108. Actual transactions also reveal information, and cannot be hidden in the IRS market no matter how they are executed, given that the Dodd-Frank Act and implementing CFTC rules mandate public disclosure of all swap trades, regardless of the type of trade venue.⁹⁰ On AA2A venues, however, only some terms of the transaction are revealed, and not the identities of the firms, which remain anonymous. At D2C RFQ venues, however, the identity of the buy-side firm is revealed. A 15-minute delay is allowed for the public reporting of sufficiently large block trades, but the size cutoff⁹¹ is extremely large, and in any case there is no distinction in the treatment of block-size delays between D2C RFQ trade and AA2A trade.
109. The adverse implications for a buy-side firm of disclosing the combination of both its name and its trading interest to dealers via D2C RFQ can be serious, especially for large buy-side firms. As evidence of this, the MFA has explained⁹² the adverse effects of information leakage of the enforced and unnecessary practice of name give-up on interdealer broker CLOBs, which has strongly discouraged buy-side firms from using

⁸⁷ Johannes Rep. ¶¶106-108 (footnotes omitted).

⁸⁸ Stefan Frey and Patrik Sandas, “The Impact of Iceberg Orders in Limit Order Books,” *Quarterly Journal of Finance*, vol. 7, no. 3 (2017), pp. 1-43.

⁸⁹ trueEX LLC Rulebook, December 3, 2015, Rule 539(a)(vi) (“An Iceberg Order will not be treated as a resting Order eligible to be matched, except to the extent of its displayable portion. Only the displayed portion of an Iceberg Order shall be visible.”).

⁹⁰ 17 CFR 45 (“Swap Data Record Keeping and Reporting Requirements”).

⁹¹ 78 FR 32866, 32942, May 31, 2013.

⁹² “Why Eliminating Post-Trade Name Disclosure Will Improve the Swaps Market,” *Managed Funds Association*, March 31, 2015, p. 1.

these venues. Evidence of the costs to buy-side firms of name give-up are discussed in detail in my opening report.⁹³

110. In my opening report, I discuss the front-running risk to a buy-side firm of revealing one's trading interest to a dealer: "Once a dealer is aware of a specific buy-side firm's likely trading intentions, that dealer is in a position to leak the information to other customers, or to use that information in the dealer's own trading, which results in price 'slippage' for the portion of the original buy-side trading interest that remains to be executed."⁹⁴
111. For example, in 2014, Reuters reported dealer front-running by the swaps-desk traders of a major dealer handling the orders of two large buy-side firms, the U.S. mortgage agencies, Fannie Mae and Freddie Mac.⁹⁵ On the basis of an intelligence bulletin of the FBI, Reuters wrote: "Using what Federal Bureau of Investigation agents described as 'unsophisticated tradecraft,' such as hand signals and special telephone ring tones, some traders are conspiring to rig rates on large orders submitted by Fannie Mae and Freddie Mac, or front running them in the interest rate swaps market."⁹⁶ In text quoted from the FBI bulletin, senior bankers at a Canadian bank and a U.S. bank "planned and encouraged this behavior because it led to higher revenue for their respective parent banks." The FBI bulletin stated that "GSEs frequently submit large interest-rate swap trades, making them easy targets for front running and lucrative targets for market manipulation." A FINRA report⁹⁷ identified the "U.S. bank" to be Bank of America Merrill Lynch.
112. The adverse impact on buy-side firms of widely reported collusive dealer front-running of customer orders in the foreign exchange market is analyzed in 2019 academic empirical research by Martin Evans, who summarizes his findings as follows:

"Recent investigations by government regulators and court proceedings reveal that there has been widespread sharing of information among Forex dealers working at major banks, as well as the regular front-running of large customer orders. I use the model to study the effects of unilateral front-running, where individual dealers trade ahead of their own customer orders; and collusive front-running where individual

⁹³ Duffie Rep. ¶¶106-122, 141.

⁹⁴ Duffie Rep. ¶168.

⁹⁵ Richard Leong, "Exclusive: FBI Suspects Front Running of Fannie, Freddie in Swaps Market," *Reuters*, January 13, 2014.

⁹⁶ Richard Leong, "Exclusive: FBI Suspects Front Running of Fannie, Freddie in Swaps Market," *Reuters*, January 13, 2014.

⁹⁷ Order Instituting Proceedings Pursuant to Section 6(c) and 6(d) of the Commodity Exchange Act, Making Findings and Imposing Remedial Sanctions, In the Matter of: Merrill, Lynch, Pierce, Fenner & Smith Incorporated, CFTC Docket No. 17-25; U.S. Attorney's Office Announces \$2.5 Million Settlement With Bank of America For Trading Ahead And Obstructing The CME's Investigation, Department of Justice, U.S. Attorney's Office, Press release. BrokerCheck Report, FINRA, Eric Alan Beckwith, CRD#4194688, Report #90039-19297, data current as of Friday, January 24, 2014.

dealers trade ahead of another dealer's customer order based on information that was shared among a group of dealers. I find that both forms of front-running create an information externality that significantly affects order flows and Forex prices by slowing down the process through which inter-dealer trading aggregates information from across the market. Front-running reduces dealers' liquidity provision costs by raising the price customers pay to purchase Forex, and lowering the price they receive when selling Forex. These cost reductions are substantial; they lower costs by more than 90 percent. Front-running also affects other market participants that are not directly involved in front-running trades. The information externality makes these participants less willing to speculate on their private information when trading with dealers. This indirect effect of front-running can reduce participants' expected returns by as much as 10 percent. My analysis also shows that collusive front-running has larger effects on order flows than unilateral front-running because information-sharing reduces the risks dealers face when trading ahead of customer orders. However, in other respects, the effects of collusive and unilateral front-running are quite similar. Greater collusion lowers the costs of providing liquidity and it reduces other participants' expected returns, but the effects are small."⁹⁸

113. Professor Johannes does not name any buy-side firm that wishes to avoid having access to anonymity. To the contrary, I have seen significant record evidence indicating a preference by specific large buy-side firms for access to anonymity.

114. [REDACTED]
[REDACTED]
[REDACTED]⁹⁹

[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]

⁹⁸ Martin Evans, "Front-Running and Collusion in Forex Trading," Working Paper, Georgetown University Department of Economics, May 30, 2019, p. 1.

⁹⁹ [REDACTED] Dep. Tr. 230:25-231:24.

[REDACTED]

115. [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]¹⁰⁰

116. [REDACTED]
[REDACTED]¹⁰¹

J. Buyside-to-buyside AA2A trade of IRS would be active and beneficial

117. Professor Johannes incorrectly suggests that buyside-to-buyside AA2A trade would be rare and would not have contributed to more competitive bid-offer spreads, because customer trading interests in IRS are not typically well matched in time or size.¹⁰² This suggestion represents a misunderstanding of how CLOB and other AA2A trade protocols work. Anonymous all-to-all trade between buyside firms does not rely on the synchronization of trading interests of buyside firms, nor on matches in their desired trading sizes. Professor Johannes also bases his claim on the pattern of buyside trade sizes and frequencies that we have seen in the actual world, in which buyside firms have had access only to D2C trade. In the actual world, there is no significant benefit or opportunity for buyside firms to exploit order shredding with frequent small trades, as there would be with AA2A trade.
118. On CLOBs, it is normal that buyers and sellers do not arrive at the market at the same time. Instead, buyers and sellers arrive in an unsynchronized fashion, posting limit orders and hitting or lifting previously posted limit orders. Limit orders (executable quotes) can rest on the order book for short or long periods of time, depending on urgency, costs of monitoring information, intensity of competition, and the degree of adverse-selection exposure to the arrival of counterparty information. Limit orders can be visible or can be

¹⁰⁰ [REDACTED] at ¶ 531.

¹⁰¹ [REDACTED]

¹⁰² Johannes Rep. ¶¶ 112-116, Exs. J, K. [REDACTED]
[REDACTED]
Exhibit 5904, [REDACTED]

“iceberg” orders,¹⁰³ which mask order sizes and are therefore popular for large order sizes. Buyer and seller order sizes need not match, or even approximately match, in order to be executed against each other.

119. For an illustrative hypothetical example, suppose BlackRock posts a limit order on an IRS CLOB to sell 10 million notional of a specific swap at the inside quote. BlackRock’s order adds to existing limit orders resting on the order book at the same price, leaving a total of 40 million notional waiting for the arrival of buyers. The prior limit orders at this price are from a mix of buy-side firms and dealers. Based on its monitoring of order formation on the CLOB, Fannie Mae decides a few minutes later to send a market order for 50 million, of which 40 million is therefore filled at the inside quote and 10 may be filled at higher prices. There is nothing unusual about this hypothetical sequence of orders and trades. It may happen, instead, that principal trading firms (“PTFs”) and competing dealers lift some of BlackRock’s offer before Fannie Mae decides to trade. That would be even better, from the viewpoint of matching efficiency, as discussed in academic research by Grossman and Miller,¹⁰⁴ but there is no need for BlackRock to rely on this.

120. The deposition in this matter of [REDACTED]

¹⁰⁵

[REDACTED]

121. The all-to-all RFQ protocol further reduces reliance on buyers and sellers of having similarly timed impetuses to trade. Moreover, all-to-all RFQ involves no presumption of

¹⁰³ Stefan Frey and Patrik Sandas, “The Impact of Iceberg Orders in Limit Order Books,” *Quarterly Journal of Finance*, vol. 7, no. 3 (2017), pp. 1-43.

¹⁰⁴ Sanford Grossman and Merton Miller, “Liquidity and Market Structure,” *Journal of Finance*, vol. 43, no. 3 (1988), pp. 617-633.

¹⁰⁵ [REDACTED] Dep. Tr. 239:25-240:24 (objections omitted).

frequent trade. In Section III.C., I describe the successful use by large asset management firms of all-to-all RFQ in the low-frequency corporate bond market.

122. For an illustrative hypothetical example, suppose that a particular type of forward rate agreement (FRA) does not have enough trade activity to support liquid CLOB trade, even in the but-for world, but is offered by some trade platform operators via all-to-all RFQ. At 10:15am on a Monday, PIMCO launches a request for quotes on 50 million notional of this FRA. Dealers and hundreds of buy-side firms who trade on this platform immediately receive an alert with the RFQ message. Of these, 10 buy-side firms and 4 dealers respond with price quotes, at quantities ranging in size from 5 million to 30 million. Because the contract is centrally cleared and trade is anonymous, PIMCO simply fills its order with the quantities available at the 4 best quoted prices, some of which are provided by buy-side firms.
123. Other anonymous all-to-all protocols used in financial markets are designed for low-frequency trade and have no need for bilateral size matching. These include double auctions, as described in my opening report.¹⁰⁶ For example, double auctions are used in the credit default swap (“CDS”) market to settle payments at the default of a firm referenced in CDS contracts.¹⁰⁷ Double auctions are also used by central counterparties for compression trade¹⁰⁸ and to liquidate the positions of failed clearing members.¹⁰⁹
124. Other forms of low-frequency anonymous all-to-all trade, which do not require buy-side firms to arrive simultaneously in order to be matched to each other, include matching sessions. Matching sessions account for approximately over 52% for investment-grade index CDS volume and over 58% of high-yield index CDS on the all-to-all (among dealers) trade platform operated by GFI.¹¹⁰
125. Regarding the value of buy-side-to-buy-side AA2A trade, Professor Johannes is relying on the sizes and frequencies of buy-side trades observed in the actual world. As I have explained in this report in Section I.C., CLOB trade naturally increases trade frequencies and reduces trade sizes, in order to get better execution. Because CLOBs support algorithmic trade, this can be done cheaply, as on BrokerTec’s treasuries platform, despite the large institutional-size trading interests in the on-the-run treasuries that are

¹⁰⁶ Duffie Rep. ¶59, fn 23.

¹⁰⁷ Songzi Du and Haoxiang Zhu, “Are CDS Auctions Biased and Inefficient?” *Journal of Finance*, vol. 72, no. 6 (2017), pp. 2589-2628.

¹⁰⁸ Darrell Duffie, “Compression Auctions, With an Application to LIBOR-SOFR Swap Conversion,” Technical Note, Graduate School of Business, Stanford University, September, 2018.

¹⁰⁹ “A Discussion Paper on Central Counterparty Default Management Auctions,” Committee on Payments and Market Infrastructures, Board of the International Organization of Securities Commissions, Bank for International Settlements, June 2019, <https://www.bis.org/cpmi/publ/d185.pdf>.

¹¹⁰ Pierre Collin-Dufresne, Benjamin Junge, Anders Trolle, “Market Structure and Transaction Costs of Index CDSs,” Swiss Finance Institute Research Paper Series No. 18-40, October 29, 2018, forthcoming, *Journal of Finance*, Table 5.

found in the interdealer treasuries market. Buyside firms that specialize in this form of trade, including PTFs, would enter the IRS market in the but-for world, as I have described in Section III.E. Other buyside firms, including some hedge funds, have this capability and would trade actively on AA2A IRS platforms. A buyside firm without its own technology for order shredding can have its large orders shredded for it by a brokerage firm.

126. Figure 2, from a December 2018 presentation¹¹¹ the Debt Management Office of the U.S. Treasury Department, shows the dramatic impact of CLOB trade on reducing the largest trade sizes, through the effect of beneficial order shredding under all-to-all competition involving algorithmic trade and PTFs. The on-run market for treasury notes (those coupon issues with 10 or fewer years to maturity) is dominated by electronic all-to-all (among dealers) trade at BrokerTec and E-Speed. As shown in Figure 2, the 90th-percentile trade sizes in each of the benchmark treasury notes is under 40% of the 90th-percentile trade sizes for the first-off-the-run of the same maturity class. Off-the-run trade is not conducted on CLOBs. When Professor Johannes opines that IRS are traded infrequently and in large size and are therefore not naturally traded at all-to-all venues,¹¹² he is basing his opinion on observed trades in the actual world. He fails to account for the impact of the introduction of all-to-all trade on reducing the largest trade sizes and on increasing trade frequency.
127. In summary, with anonymous all-to-all trade of IRS products, buyside firms can take advantage of the opportunity to trade with other buyside firms, without the need to rely exclusively on dealers for quote provision. This increases competition for quote provision, reducing bid-offer spreads, thus lowering buyside trading costs, with positive feedback effects through the entry of new buyside firms. Anonymous all-to-all trade also provides opportunities for buyside firms to earn profits with quote provision, furthering lowering their average trade costs. This practice is common in existing exchange markets.

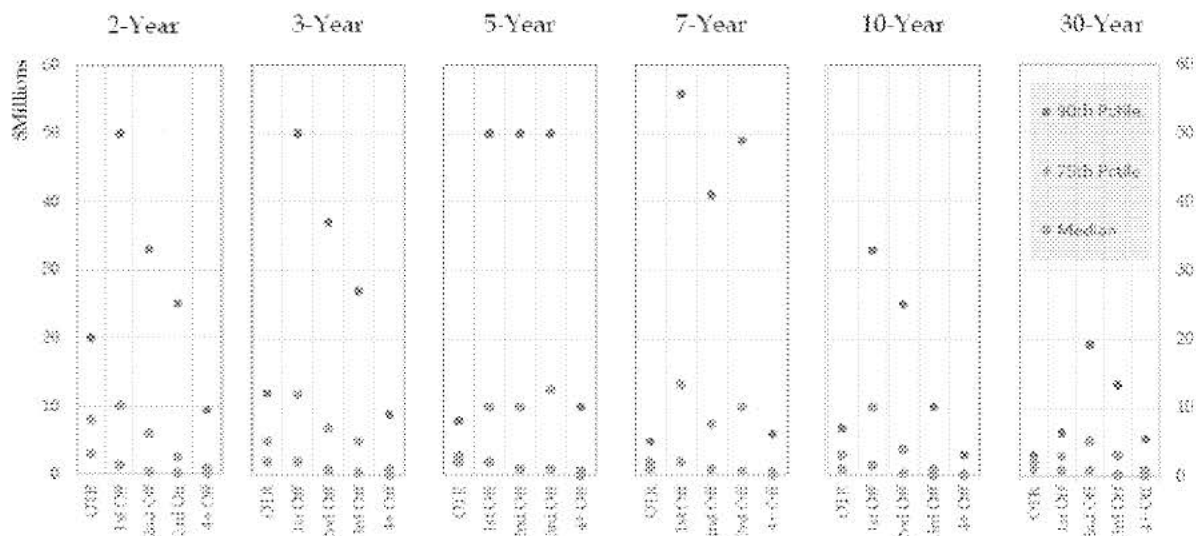
III. DEFENDANT-EXPERT ANALYSES OF OTHER MARKETS ARE MISLEADING AND DO NOT IMPLY THAT ALL-TO-ALL IRS TRADE IS INFEASIBLE OR LACKS BUYSIDE BENEFITS

128. In my opening report, I illustrate the viability and buyside benefits of anonymous all-to-all in several other financial markets, in order to illustrate the but-for viability and buyside benefits of AA2A trade of the four classes of standardized IRS products that are the focus of my opinions in this case.

¹¹¹ The Evolving Structure of the U.S. Treasury Market, Fourth Annual Conference, Office of Debt Management, The Department of the Treasury, https://home.treasury.gov/system/files/136/TRACE_Phillips_120318_Presentation_FINAL.pdf.

¹¹² Johannes Rep. ¶¶24, 65, 71.

Figure 2. Trade Sizes for U.S. Treasury Benchmark Maturities. Source: Debt Management Office of the U.S. Treasury Department.¹¹³



Notes

- Data from August 2017 to October 2018
- Includes all venues
- Excludes when-issued

129. Professor Johannes and Professor Culp also consider a selection of other financial markets, including¹¹⁴ those for index CDS,¹¹⁵ treasuries,¹¹⁶ European and Canadian sovereign bonds,¹¹⁷ corporate bonds,¹¹⁸ and equity options.¹¹⁹ Some of their examples overlap with those that I offered. Yet, the Defendants' experts argue that none of these financial markets offer evidence in support of the viability or buy-side benefits of AA2A trade of IRS products. In this section, I take issue with their arguments.

¹¹³ The Evolving Structure of the U.S. Treasury Market, Fourth Annual Conference, Office of Debt Management, The Department of the Treasury, https://home.treasury.gov/system/files/136/TRACE_Phillips_120318_Presentation_FINAL.pdf.

¹¹⁴ Professor Johannes also considers the case of ICE trade of futures on certain types of energy swaps. Johannes Rep. ¶¶185–194. He is correct that this migration of energy swap trading onto ICE's futures market had a tailwind of regulatory arbitrage. Exchange trading was nevertheless demonstrably viable. If the Defendants' experts were correct about the high costs to buy-side firms of exchange trading, this migration would not have been successful.

¹¹⁵ Johannes Rep. ¶¶140–143.

¹¹⁶ Johannes Rep. ¶¶144–161, Ex. M.

¹¹⁷ Johannes Rep. ¶¶162–166.

¹¹⁸ Johannes Rep. ¶¶167–177.

¹¹⁹ Johannes Rep. ¶¶178–184.

A. Index credit default swaps

130. The Defendants' experts suggest that the CDS index market offers evidence in support of the notion that buy-side firms in the IRS market would not benefit from the existence of anonymous all-to-all trade, or that this form of trade could not exist. I disagree.
131. Professor Johannes¹²⁰ and Dr. Culp¹²¹ suggest that the index CDS market provides price benefits to customers based on their relationships with dealers, citing Riggs, Onur, Reiffen, and Zhu (2019).¹²² As I explained in Paragraph 79, Riggs, Onur, Reiffen, and Zhu (2019) find no statistically significant relationship between customer-to-dealer relationship and quoted spreads at D2C RFQ venues in the CDS index market.
132. Professor Johannes states: "Academic research demonstrates that customers pay less in transaction costs for Index CDS through name-disclosed D2C trading compared to the cost of trading the same Index CDS on the Interdealer market."¹²³ In a footnote, he continues, "These findings hold true both before and after regulatory changes due to the Dodd-Frank Act." Yet, for this fact he cites only a pre-Dodd-Frank source, Gündüz, Lüdecke, and Uhrig-Homburg (2007).¹²⁴ Moreover, this pre-Dodd-Frank source and the work that Professor Johannes later cites by Collin-Dufresne, Junge, and Trolle do not actually support his claim. They find precisely the opposite!
133. Gündüz, Lüdecke, and Uhrig-Homburg (2007) find "higher liquidity costs in the brokered market" than in the "direct interdealer trading market." Collin-Dufresne, Junge, and Trolle¹²⁵ find that effective customer-to-dealer bid-offer spreads at D2C RFQ venues are about 40% *larger* than bid-offer spreads on CLOB interdealer platform. More specifically, these authors write: "We find that transaction costs of D2C trades are higher than those of D2D trades, on average. For CDX.IG, average transaction costs of D2C and D2D trades are 0.138 basis points (bps) and 0.098 bps, respectively, with the difference of 0.040 bps being statistically significant. The corresponding figures for CDX.HY are

¹²⁰ Johannes Rep. ¶85.

¹²¹ Culp Rep. ¶305.

¹²² Lynn Riggs, Esen Onur, David Reiffen, and Haoxiang Zhu, "Swap Trading after Dodd-Frank: Evidence from Index CDS," Working Paper, August 17, 2019, forthcoming, *Journal of Financial Economics*.

¹²³ Johannes Rep. ¶142.

¹²⁴ Yalin Gündüz, Torsten Lüdecke, and Marliese Uhrig-Homburg, "Trading Credit Default Swaps via Interdealer Brokers," *Journal of Financial Services Research*, vol. 32 (2007), pp. 141-159.

¹²⁵ Pierre Collin-Dufresne, Benjamin Junge, Anders Trolle, "Market Structure and Transaction Costs of Index CDSs," Swiss Finance Institute Research Paper Series No. 18-40, October 29, 2018, forthcoming, *Journal of Finance*.

0.676 bps and 0.494 bps, with the difference of 0.181 bps again being statistically significant.”¹²⁶

134. This is contrary to the Defendants’ experts’ suggestions in various places in their reports that D2C RFQ bid-offer spreads are on average smaller than AA2A bid-offer spreads because customers can identify themselves in D2C RFQ trades as relatively uninformed. In fact, from their dynamic price-impact analysis, Collin-Dufresne, Junge, and Trolle find that transaction costs are *higher* for D2C RFQ trades than D2D trades because customers are *more* informed than dealers, not less informed. This is consistent with the point that Defendants’ experts make about the role of adverse selection affecting quote sizes, but leads to a conclusion regarding relative trade costs, D2C RFQ versus D2D, that is *opposite* to that suggested by the Defendants’ experts.
135. Indeed, Collin-Dufresne, Junge, and Trolle surmise that customers are significantly motivated to trade because of their private information, whereas dealers are motivated to trade in order to reduce inventory imbalances.
136. Moreover, Professor Johannes admitted in his deposition that a [REDACTED]
[REDACTED]
[REDACTED]¹²⁷
137. The upshot is that in a but-for world in which there is active anonymous all-to-all trade of CDS index products, customers of dealers would on average strictly prefer to trade at AA2A venues than on D2C RFQ venues.
138. Collin-Dufresne, Junge, and Trolle discovered a key reason for the cost of D2D trade to be so much lower on the anonymous all-to-all (among dealers) platform than in the D2C RFQ market. Over two thirds of the interdealer platform trades are executed with size-discovery protocols (workup and mid-point matching) that have no bid-offer spread and no price impact. Professor Johannes admitted this in his deposition.¹²⁸ As I have stated, size-discovery trade avoids bid-offer and price-impact costs because of the existence of price discovery from the limit order book market. Size-discovery trade is available as an option to investors that are not inhibited by execution delays, given the transactions cost savings.
139. Professor Johannes suggests that anonymous all-to-all trade would not be introduced into the CDS index market because relatively less informed buy-side firms would opt out of AA2A venues in order to trade in D2C RFQs. I disagree. The results of Collin-Dufresne, Junge, and Trolle imply that there would be plenty of informed buy-side investors that would be selected into AA2A trading by virtue of having private information. There

¹²⁶ Pierre Collin-Dufresne, Benjamin Junge, Anders Trolle, “Market Structure and Transaction Costs of Index CDSs,” Swiss Finance Institute Research Paper Series No. 18-40, October 29, 2018, forthcoming, *Journal of Finance* (footnote omitted).

¹²⁷ Johannes Dep. Tr. 382:18-384:24.

¹²⁸ Johannes Dep. Tr. 264:19-265:14.

would be many additional entrants to AA2A trading because of the other advantages that I have already outlined (reductions in bid-offer spreads induced by competition and transparency, reduced ongoing operational costs, reduced setup costs, and the opportunity to profit from quote provision).

140. Professor Johannes uses the fact that there has been no active anonymous all-to-all trade of CDS index products to support his suggestion that this is also the natural status for the IRS market.¹²⁹ Yet the CDS index market was itself the subject of recent litigation over allegations that major dealers blocked the introduction of anonymous all-to-all trade. In that litigation, the defendants settled for approximately \$1.8 billion in late 2015. Professor Johannes footnotes investigations by the European Commission and the Antitrust Division of the U.S. Department of Justice of anti-competitive conduct in the CDS market but does not mention the private litigation and its settlement. As I indicated in my deposition, although I was privy to the discovery record in that case, I am unable to comment on what I learned about that market due to the protective order entered in that case.¹³⁰ At the very least, this background suggests that the CDS index market is not a suitable proxy for the but-for IRS market, because the CDS market may have been affected by dealer-created obstacles similar to those alleged for the IRS market.
141. A major impediment to buy-side participation in all-to-all trade platforms for CDS index products has been the practice of post-trade name give-up on CLOB platforms. This practice causes uncontrolled release of the identities of buy-side firms, thus leakage of information concerning a buy-side firm's trading strategies. In Section III.F of my opening report I provide additional details and buy-side complaints about this practice, which also applies to CLOB trade as it has existed in the CDS index market, inhibiting participation by buy-side firms.
142. Because of the history of litigation in the CDS index market, the practice of name give-up, the fact the D2C RFQ transactions costs are actually higher than D2D transactions costs, and the other arguments that I have stated, I believe that the absence of active anonymous all-to-all trade in the CDS index market is not a suitable basis for Professor Johannes' inference that the anonymous all-to-all trade would not work in the IRS market. To the contrary, everything we know about the CDS index market suggests that AA2A trade is viable in both that market, and for trade of the four types of standardized IRS products at issue here.

¹²⁹ Johannes Rep. ¶¶140-141.

¹³⁰ Duffie Dep. Tr. 222:21-223:10.

B. Equity options

143. Professor Johannes suggests that the introduction of exchange trading of equity options, one of the most successful examples of financial innovation in history,¹³¹ was not valuable to institutional (large buy-side) firms.¹³² Equity options now trade actively on 13 different exchanges in the United States alone, with a total volume in 2018 of option contracts covering over 450 billion shares.¹³³ According to the Bank for International Settlements,¹³⁴ in March 2014 equity index options trading on exchanges covered a notional amount of over \$5.9 trillion.
144. Professor Johannes proposes that equity option exchange trading is not useful for “institutional” firms based on the fact that, according to the sources he cites, these firms trade more of these instruments over the counter than on exchanges. Yet the amounts that these firms trade on equity exchanges, by his cited figures, are substantial. Moreover, the amounts that these firms trade on exchanges and OTC are both likely to be far larger than they be in a world in which exchange trading had somehow been blocked. This is so because exchange trading improves overall market liquidity through price discovery and through entry into the market by many additional investors.
145. For example, as I stated in my opening report, the total volume of exchange trade in the first complete month of exchange trading of equity options in 1973 was larger than the average monthly volume in any prior *year* of OTC trade.¹³⁵ When describing the history of development of the equity options market, Hill and Dunn¹³⁶ show that exchange-traded equity index option trading became important in the United States *before* significant OTC-market development of equity index option products. Index equity options are the most important component of the OTC equity options market.
146. In the but-for world, the introduction of anonymous all-to-all trade of IRS would likewise have stimulated overall trade activity in the IRS market, both all-to-all and OTC.

¹³¹ Joanne Hill and Barbara Dunn, “A Historical Perspective on Equity Derivatives,” in Jack Clark Francis, William W. Toy, J. Gregg Whittaker, eds.: *The Handbook of Equity Derivatives*, Revised Edition, 2000, Boston: Wiley.

¹³² Johannes Rep. ¶¶178-184.

¹³³ Of 16 U.S. exchanges for equity options with trade in activity in 2018, I exclude those handling less than 1% of the total, even though these 3 exchanges also have substantial trading. I assume the standard contract size, covering a round lot of 100 shares. These statistics are drawn from the web page of the Options Clearing Corporation at <https://www.theocc.com/webapps/historical-volume-query>.

¹³⁴ Statistical Annex, *BIS Quarterly Review*, June 2014, https://www.bis.org/publ/qtrpdf/r_qa1406.pdf.

¹³⁵ Duffie Rep. ¶65.

¹³⁶ Joanne Hill and Barbara Dunn, “A Historical Perspective on Equity Derivatives,” in Jack Clark Francis, William W. Toy, J. Gregg Whittaker, eds.: *The Handbook of Equity Derivatives*, Revised Edition, 2000, Boston: Wiley.

147. A 2014 letter to the SEC from the Edward Tilly, CEO of the Chicago Board Options Exchange casts doubt on whether institutional customers of dealers are getting best execution when they are being recommended trades in the OTC market. Tilly writes:

“The benefits to investors of trading exchange-traded, standardized options over trading OTC options is well established. Investors in exchange-traded options enjoy greater price discovery, price improvement and secondary market liquidity than investors in comparable OTC options. Moreover, market participants benefit generally from exchange transactions over OTC transactions due to trade reporting, exchange surveillance of trading and anti-manipulation rules, and increased secondary market liquidity in those options. Because exchange trades in standardized options are also centrally cleared, market participants enjoy the lack of counterparty risk, operational standardization, and greater possibilities to hedge options positions with positions in other instruments, including standardized options. Clearing agency netting of positions also reduces risk to the financial system generally.

Despite the relative benefits of exchange trades in standardized options, CBOE is concerned that certain market participants may instead be recommending OTC options transactions to their institutional customers, even when substantially identical standardized options are available, resulting in market fragmentation, reduced liquidity, reduced price transparency, and often inferior prices for the institutional customers (and market participants generally) than if the trades had been effected on a national securities exchange. One reason for this recommendation may be a form of regulatory arbitrage by market participants, as exchange members are required to comply with a host of rules regarding trading, for the protection of investors, while market participants trading OTC options are subjected to a lighter regulatory regime.

Although the lighter regulatory burden of OTC options trades may benefit certain broker-dealers effecting OTC options trades, OTC trading often does not inure to the benefit of OTC options customers or to the marketplace as a whole. When options transactions are effected OTC, market participants do not receive the order interaction and price discovery benefits of transactions effected on options exchanges. This is true not just for the OTC options customers, but also for the customers of options transactions effected on a national securities exchange, as their orders never have the opportunity to interact with OTC options customers. Although, presumably, OTC options traders may rely on open exchange orders and last sale reporting to inform their pricing of OTC options trades, customers on options exchanges do not receive similar knowledge of the price and size of OTC options orders or last sale information regarding similar OTC options transactions when

pricing their exchange orders. Moreover, because OTC options trades are not reported, CBOE (and other regulators) may be unaware of the relationship between OTC options and standardized options transactions (or transactions in other instruments) and therefore would have difficulty surveilling for any legal or regulatory issues raised by OTC options transactions."¹³⁷

148. Buyside firms, including institutional firms, want the ability to trade both OTC and on exchanges. Buyside firms, including institutional investors, trade a large quantity of equity options on exchanges. The existence of exchange trade also disciplines dealer quotes in the OTC market through the ability to substitute with exchange trade and through the effect of exchange price discovery. Tilly's 2014 letter states several additional benefits to buyside investors, including institutional investors, of exchange trade of equity options. Additional buyside benefits of exchange trade are covered in detail in my opening report.

C. Corporate bonds

149. Professor Johannes suggests that the corporate bond market is unsuitable for all-to-all trade. I disagree. According to Professor Johannes, "Anonymous all-to-all trading of corporate bonds has not been widely adopted for several of the same reasons it has not been widely adopted for IRS. Like IRS and unlike individual equities, there are a huge number of corporate bonds that trade relatively infrequently. The corporate bond market also exhibits sporadic liquidity... In addition, typical investment grade corporate bond trade sizes are approximately 70 times larger than the typical equity trade sizes... Because of the number of bonds, infrequent trading, and large trade sizes, market participants generally need dealers to intermediate trading and provide liquidity for trading."¹³⁸
150. The evidence from MarketAxess' Open Trading¹³⁹ is that anonymous all-to-all trade of corporate bonds is both viable and active, even in a market which, like the IRS market, has a large number of distinct instruments. As I explained in my opening report, for instruments that are less frequently traded, other forms of anonymous all-to-all trade can succeed. Open Trading uses an anonymous all-to-all RFQ trade protocol. In 2017, Open Trading had 705 quote providers who responded to 2.1 million requests for quotes and executed 627,000 trades, with an average daily trade volume of \$970 million.¹⁴⁰ Of total volume on the largest corporate bond trading platform, MarketAxess, AA2A trade

¹³⁷ Letter from Edward T. Tilly (CBOE, CEO) to Stephen I. Luparello (SEC, Division of Trading and Markets, Director), re: Inappropriate Trading in OTC Options where Substantially Identical Standardized Options are Available, October 2, 2014, p. 2.

¹³⁸ Johannes Rep. ¶174. His footnotes are omitted here.

¹³⁹ Open Trading, The New Paradigm for Sourcing Liquidity—Join the Open Market Revolution, MarketAxess.

¹⁴⁰ Russell Investments Case Study, MarketAxess, 2018.

accounted for 17% of 2017 investment grade volume. MarketAxess estimates that “the narrower spreads available through Open Trading saved participants an estimated \$89 million versus the average spreads for disclosed trading for the year.” According to MarketAxess’ public disclosure, it handled about \$232 billion volume in Open Trading in 2017.¹⁴¹ Thus, an \$89 million cost savings represents a cost reduction of about 3.8 basis points of transaction volume.

151. In 2017, the financial industry market-structure analyst Greenwich Associates stated that “New entrants and offerings are increasing the size of the pie rather than stealing share. MarketAxess’ Open Trading all-to-all offering is one example, with 38% of the volume executed on that part of the platform taking the form of high-yield bonds.”¹⁴²
152. One of the largest fixed-income trading firms, Russell Investments, makes heavy use of Open Trading. Brandon Rasmussen, Head of Fixed Income Trading at Seattle-based Russell Investments stated that¹⁴³ “Open Trading contributed about 7% of all our U.S. dollar credit traded volume for 2016, and 11% in 2017.” High yield bonds present far more adverse-selection concerns to quote providers than do IRS, given the much greater scope for private information about the credit quality of “junk” bond issuers. Yet anonymous all-to-all trade on Open Trading constituted 11% of Russell Investments high-yield trade volume in 2016 and 16% in 2017. In this respect, Rasmussen stated: “That demonstrates the importance of being able to access non-traditional liquidity providers, as Open Trading made up our largest source of liquidity.”¹⁴⁴
153. Laurent Albert, Deputy CEO and Global Head of Execution of another large asset management firm, Natixis, stated that anonymity on Open Trading “allows us to capture more liquidity without directly facing the provider, and keep better control of our information.”¹⁴⁵
154. David Parker, head of sales for all-to-all bond trade platform MTS BondsPro, remarked that: “By connecting to one all-to-all venue like MTS BondsPro, for example, an alternative liquidity provider such as an asset manager or algorithmic market maker can show its pricing and trade with 1,000 other end users from all corners of the market – with just one outbound connection. The growth in this type of trading has been significant – over 40% of the institutional volume on BondsPro in the first quarter of

¹⁴¹ MarketAxess Holdings Inc., Form 10-K/A, December 31, 2018, pp. 5, 8 (where Open Trading volume represented 15.9% of MarketAxess platform volume of \$1,458.3 billion).

¹⁴² Greenwich Associates, “Technology Transforming a Vast Corporate Bond Market,” Q4, 2017, p. 5.

¹⁴³ Russell Investments Case Study, MarketAxess, 2018, p. 1.

¹⁴⁴ Russell Investments Case Study, MarketAxess, 2018, p. 2.

¹⁴⁵ Natixis Case Study, MarketAxess, March 2019, p. 3.

2018 was from non-traditional liquidity, and that proportion has doubled each year since 2016.”¹⁴⁶

155. Other all-to-all corporate bond platform providers include Tradeweb (Tradeweb Blast A2A),¹⁴⁷ Trumid (Trumid Market Center),¹⁴⁸ and Liquidnet (Liquidnet Fixed Income).¹⁴⁹
156. Corporate bonds are highly heterogeneous and nonstandard, in terms of issuer, rating, maturity, coupon rate, optionality, and other terms, with a large number of CUSIPs. The fact that anonymous all-to-all trade in corporate bond markets is nevertheless viable supports my point that heterogeneity of IRS products is not a reason for lack of viability of anonymous all-to-all trade of IRS. As I stated in my opening report, for financial instruments that are too thinly traded to support an active central limit order book, other anonymous all-to-all trade protocols, such as all-to-all RFQ, are viable and beneficial to buy-side firms.
157. There is also evidence of price discipline in the corporate bond market. Empirical research by Goldstein, Hotchkiss, and Sirri (2007)¹⁵⁰ and Bessembinder, Maxwell, and Venkataraman (2006),¹⁵¹ published in leading peer-reviewed academic journals, finds that the introduction of post-trade price transparency through TRACE significantly lowered trading costs for most types of corporate bond transactions, including bonds that were not TRACE-eligible at the time.
158. In his deposition in this matter, Professor Johannes admitted, as follows, this finding from the research of Bessembinder, Maxwell, and Venkataraman (2006),¹⁵² which he cited.

“A. So what they find is that TRACE is post-trade reporting. So after the trades consummate the trade is reported on TRACE and the authors

¹⁴⁶ David Parker, “Industry viewpoint MTS,” Fi-Desk, June 4, 2018, <https://www.fi-desk.com/industry-viewpoint-mts-david-parker/>.

¹⁴⁷ Tradeweb Launches All-to-All Corporate Bond Trading, Tradeweb Press Release, May 1, 2017, <https://www.tradeweb.com/newsroom/media-center/news-releases/tradeweb-launches-all-to-all-corporate-bond-trading#>.

¹⁴⁸ Trumid Market Center 2.0, Trumid, <https://www.trumid.com/product.html>.

¹⁴⁹ Fixed Income Trading Solutions, Liquidnet, 2019, <https://www.liquidnet.com/fixed-income-solutions>.

¹⁵⁰ See Table 7 of Michael A. Goldstein, Edith S. Hotchkiss, and Erik R. Sirri, “Transparency and Liquidity: A Controlled Experiment on Corporate Bonds,” *Review of Financial Studies*, vol. 20, no. 2 (2007), pp. 235-273.

¹⁵¹ See Table 4 of Hendrik Bessembinder, William Maxwell, and Kumar Venkataraman, “Market Transparency, Liquidity Externalities, and Institutional Trading Costs in Corporate Bonds,” *Journal of Financial Economics*, vol. 82 (2006), pp. 251-288.

¹⁵² Hendrik Bessembinder, William Maxwell, and Kumar Venkataraman, “Market Transparency, Liquidity Externalities, and Institutional Trading Costs in Corporate Bonds,” *Journal of Financial Economics*, vol. 82 (2006), pp. 251-288.

find that trade executions -- execution costs did fall 50 percent for the bonds eligible for TRACE, yes.

Q. And they also found that prices on bonds that were not eligible for TRACE fell by approximately 20 percent, right?

A. Yeah. That's what they found.

Q. And they call that a liquidity externality. What does that term mean?

A. That's a complicated term to define precisely but I think what they are referring to is the fact that post-trade transaction reporting had an affect both for the bonds that were reported and for the other bonds.

Q. Would you call that propagation, spillover, what word would you use to describe that? ...

A. You can use a lot of words to describe the effective post-trade trade transparency. The effect from reporting trades there was an affect both in the TRACE and non-TRACE bonds. ”¹⁵³

159. In widely cited research, Biais and Green (2019)¹⁵⁴ write: “Bonds are traded in opaque and fragmented over-the-counter markets. Is there something special about bonds precluding transparent limit-order markets? Historical experience suggests this is not the case.” Biais and Green provide extensive quantitative evidence that in the early part of the 20th century, corporate and municipal bonds were actually more actively traded on exchanges than over the counter. In fact, corporate bonds were more actively traded on exchanges than equities. They write:

“That bonds command transactions costs, larger than for stocks, is surprising. Risk is one of the main components of the cost of supplying liquidity. Bonds are less risky than stocks. They should have lower spreads. The large transaction costs paid by final investors in the bond market could reflect dealers’ market power. Indeed, Green et al. (2007) find that dealers in the municipal bond market exercise substantial market power. In the corporate bond market, DiMaggio et al (2016) find that, when dealers trade with clients (as opposed to other dealers), they charge an extra markup of about 50 basis points. But could transactions costs be lowered by trading bonds in transparent centralized limit order market instead of a fragmented dealer market? It is difficult to answer that question without a counterfactual. While modern bond markets don’t offer such a counterfactual, historical experience does. ”¹⁵⁵

¹⁵³ Johannes Dep. Tr. 319:19-321:5 (objections omitted).

¹⁵⁴ Bruno Biais and Richard Green, “The Microstructure of the Bond Market in the 20th Century,” *Review of Economic Dynamics*, vol. 33 (2019), pp. 250-271.

¹⁵⁵ Biais and Green cite the following research: Richard C. Green, Burton Hollifield, and Norman Schurhoff, “Financial Intermediation and the Costs of Trading in an Opaque Market,” *Review of Financial Studies*, vol. 20, no. 2 (2007), pp. 275-314 and Marco Di Maggio, Amir Kermani, and

160. Professor Johannes is correct that most corporate bond trading is still not done using AA2A trade protocols. However, based on the body of factual evidence that I have presented, I believe that Professor Johannes is mistaken when expressing the opinion that corporate bonds are unsuitable for anonymous all-to-all trade.

D. Foreign sovereign bonds

161. Professor Johannes suggests that Canadian and European sovereign bonds are not natural candidates for anonymous all-to-all trade.¹⁵⁶ I disagree.
162. There is extensive evidence of anonymous CLOB trade of European government bonds. In the case of cash securities, CLOB trade is mainly among dealers but that fact is determined by platform rules, as I will detail later in this section. I will discuss other institutional impediments to buy-side participation on sovereign bond CLOBs, including BrokerTec's platform for U.S. treasuries, which I address in the next subsection. I will also provide evidence that significant AA2A trade of sovereign bond futures contracts evidences strong viability and buy-side benefits, and in some cases dominates the trade of the underlying "cash" securities.
163. Even though some buy-side trades of sovereign bonds are more cheaply executed by D2C RFQ, buy-side costs for using OTC trade protocols are lowered by the existence of parallel anonymous all-to-all trade.
164. For example, in an academic research paper cited by Professor Johannes for unrelated reasons, Dunne, Hau, and Moore (2010) write:

*"Our evidence for the European sovereign bond market suggests that high market transparency in the B2B segment may have beneficial externalities for the market quality in the B2C market. We also highlight that the high average quality of B2C transactions extends to the less liquid bond issues, which do not feature a benchmark status. Such findings can contribute to the ongoing policy debate about the benefits of post-trade transparency."*¹⁵⁷ [The authors use "B" to indicate "dealer" (D).]

165. Professor Johannes does not mention this finding of Dunne, Hau, and Moore (2010). Professor Johannes also fails to mention the explanation given by Dunne, Hau, and Moore (2010) for the absence of trade by buy-side firms on CLOB platform, MTS, that they study, namely that "clients are excluded from participation in the B2B [D2D] market

Zhaogang Song, "The Value of Trading Relations in Turbulent Times," *Journal of Financial Economics*, vol. 124 (2017), pp. 266-284.

¹⁵⁶ Johannes Rep. ¶¶162-166.

¹⁵⁷ Peter Dunne, Harald Hau, Michael Moore, "A Tale of Two Platforms: Dealer Intermediation in the European Sovereign Bond Market," INSEAD Working Paper No. 2010/64/FIN, August 13, 2010, p. 3.

and have to transact directly with a dealer. This creates a dual market structure with a B2B and B2C segment.”¹⁵⁸

166. The platform operator MTS now offers dealers CLOB trade of cash bonds issued by many different European governments. MTS states that its sovereign bond platform “is an order-driven multilateral trading facility (“MTF”) operated by EuroMTS Limited (“MTS”), allowing all participants full functionality and no quoting requirements in accessing an order book that displays bid and ask prices for a very wide range of European government bonds.” Trade is among “500 counterparties and 2,000 traders trading an average daily volume exceeding EUR 100 billion across all MTS platforms.”¹⁵⁹
167. MTS, which is by far Europe’s most active cash-instrument government bond trading platform, uses a variant of the CLOB protocol in which only designated dealers are permitted to provide quotes, whereas both dealers and buy-side firms are permitted to accept quotes.¹⁶⁰ In this sense, it is purely the mechanical result of a platform rule that buy-side firms are unable to participate in true all-to-all trade. Some buy-side firms would profit from the option to participate fully with the ability to make and take quotes, while none would suffer from having the option. In any case, buy-side firms do frequently avail themselves of dealer quotes on sovereign bond CLOBs, contrary to the suggestion of Professor Johannes.
168. The rule-based exclusion of buy-side firms from providing quotes on government bond IDB trading platforms relegates buy-side firms to trade via accepting quotes from dealers. Dealers have the incentive to maintain their exclusive access to quote provision on anonymous CLOBs for bonds. In this two-tier market structure, dealers have 100% of the profitable market for quote provision. Platforms on which multiple dealers provide quotes provide more competition than the bilateral D2C market, but are not as competitive nor as beneficial to buy-side firms as all-to-all trade platforms.
169. Like BrokerTec, MTS provides a size-discovery protocol that allows trading at the midpoint, without a bid-offer spread and price impact costs. “MidPrice on the MTS Cash interdealer platform offers an orderly method of price discovery, based on real executable

¹⁵⁸ Peter Dunne, Harald Hau, Michael Moore, “A Tale of Two Platforms: Dealer Intermediation in the European Sovereign Bond Market,” INSEAD Working Paper No. 2010/64/FIN, August 13, 2010, p. 13.

¹⁵⁹ EBM Factsheet, MTS, London Stock Exchange Group, https://www.mtsmarkets.com/sites/default/files/content/documents/MTS_0494_MTS_Cash_EBM_Factsheet_NEWLOGO_V12.pdf.

¹⁶⁰ Madhucchand Darbha and Alfonso Dufour, “Microstructure of the Euro-Area Government Bond Market,” in H Kent Baker, and Halil Kiymaz, eds.: *Market Microstructure in Emerging and Developed Markets*, 2013, Wiley Online Library.

market rates. It was developed to enable dealers to work large orders efficiently without moving the market.”¹⁶¹

170. Professor Johannes cites the empirical research of Dunne, Hau, and Moore¹⁶² as a source of support for the notion that D2C RFQ bid-offer spreads are smaller than D2D bid-offer spreads. The authors of the study that Professor Johannes cites, however, were apparently also unaware that dealers can achieve mid-point pricing using size-discovery protocols available on MTS. (The authors never mention protocols for D2D trade other than CLOB, and obtain their D2D bid and offer data exclusively from CLOB quotes.) Professor Johannes also fails to note the role of size discovery in his own comparison of D2C RFQ and D2D bid-offer spreads, writing as though D2D bid-offer spreads determine D2D trade costs. If half of D2D trade is conducted by size-discovery protocols, as is the case for BrokerTec trade of U.S. treasuries,¹⁶³ then bid-offer spreads overstate transaction costs by roughly a factor of two.
171. Professor Johannes does not mention that the results of Dunne, Hau, and Moore show how buy-side D2C RFQ trading costs can be *increased* by customer relationships through the exercise of dealer market power, as I explained earlier. These authors find that:

*“A second important feature of the data concerns the high degree of B2C [D2C] price dispersion relative to the best inter-dealer quote. Such price dispersion is difficult to reconcile with a perfectly competitive setting between dealers and customers. We argue in this paper that dealer inventory management concerns are important for explaining the B2C price behavior. Under inventory constraints, dealers find it optimal to quote inventory-contingent B2C prices, provided that their dealer-client relationship grants them some degree of market power. Inventory dispersion among dealers can thus explain the observed cross sectional B2C price dispersion. We also explore whether customer heterogeneity or varying degrees of quote competition can account for the B2C quote dispersion. While corresponding proxies show some price influence, they do not seem to invalidate the role of inventory effects as an important determinant of B2C quote quality.”*¹⁶⁴

¹⁶¹ MTS MidPrice, MTS, London Stock Exchange Group, 2019, <https://www.mtsmarkets.com/products/mts-cash/mts-midprice>.

¹⁶² Peter Dunne, Harald Hau, Michael Moore, “A Tale of Two Platforms: Dealer Intermediation in the European Sovereign Bond Market,” INSEAD Working Paper No. 2010/64/FIN, August 13, 2010.

¹⁶³ Michael Fleming and Giang Nguyen, “Order Flow Segmentation and the Role of Dark Trading in the Price Discovery of U.S. Treasury Securities,” Federal Reserve Bank of New York Staff Reports, Staff Report No. 624, August 2013.

¹⁶⁴ Peter Dunne, Harald Hau, Michael Moore, “A Tale of Two Platforms: Dealer Intermediation in the European Sovereign Bond Market,” INSEAD Working Paper No. 2010/64/FIN, August 13, 2010, p. 3.

172. As I stated in my opening report, dealer inventory costs are partially passed on to customers. Buyside trading costs are therefore reduced if dealers can take advantage of anonymous all-to-all trade to more efficiently rebalance their inventories.
173. Evidence of the inventory costs that IRS dealers pass to customers is available in research conducted by Bank of England staff, who “find substantial and persistent heterogeneity in derivatives prices consistent with a pass-through of regulatory costs on to market prices via the so-called valuation adjustments (XVA). Specifically, a client pays a higher price to buy interest-rate protection from a dealer (i.e., the client pays a higher fixed rate) if the contract is not cleared via a central counterparty.”¹⁶⁵ Further, for contracts that are centrally cleared, D2C RFQ trade exacerbates dealer inventory costs relative to anonymous all-to-all trade by keeping a larger fraction of outstanding positions on dealer balance sheets, where they must be funded at a cost to dealer shareholders and backed by capital that meets regulatory capital requirements. These costs are explained and modeled in my research with Leif Andersen and Yang Song.¹⁶⁶ With the D2C RFQ model, essentially 100% of IRS positions have at least one dealer counterparty that bears these costs.
174. BrokerTec provides anonymous all-to-all (among dealers) trade for the government bonds of Belgium, The Netherlands, Ireland, Austria, Portugal, Finland, France, Germany, and Italy.¹⁶⁷ BrokerTec trade volume is not trivial, but is small relative to total market trade volumes. By its rules, BrokerTec does not allow buyside firms onto these platforms.¹⁶⁸ If that were not the case, I believe there would be active buyside participation.

¹⁶⁵ Gino Cenedese, Angelo Ranaldo, and Michalis Vasios, “OTC Premia,” Bank of England, Staff Working Paper No. 751, August 2018.

¹⁶⁶ Leif Andersen, Darrell Duffie, and Yang Song “Funding Value Adjustments,” *Journal of Finance*, vol. 74, no. 1 (2019), pp. 145-192.

¹⁶⁷ BrokerTec Regulatory Documents, CME Group, 2019, <https://www.cmegroup.com/trading/market-tech-and-data-services/brokertec/regdocs.html#all-documentation>.

¹⁶⁸ BrokerTec EU RM Rulebook, CME Group, 2019, <https://www.cmegroup.com/trading/market-tech-and-data-services/files/brokertec-eu-rm-rulebook-appendix-government-bonds.pdf>.

175. Anonymous all-to-all trade of futures on European sovereign bonds occurs on the limit order books of various exchanges, including a range of contracts traded at the exchanges operated by Eurex¹⁶⁹ and ICE.¹⁷⁰
176. For example, in August 2019, the total trade volume on the Eurex exchange of German government bond (“bund”) futures was 15,566,214 contracts, each of 100,000 euros notional, for a total monthly trade volume of over 1.5 trillion euros, heavily dominating the volume of dealer-intermediated “cash” trade of bunds in the over-the-counter market, as I detail in Section II.G.¹⁷¹
177. Professor Johannes uses the case of Canadian sovereign bonds to support his suggestion that sovereign bonds are not viably traded on anonymous all-to-all platforms. He does not mention that there is in fact AA2A trade of Canadian government bonds at CBID,¹⁷² and of Australian sovereign bonds on the Australian Stock Exchange.¹⁷³ In both cases, however, trading is thin. Both of these countries have relatively concentrated dealer markets. I am aware of no evidence that anonymous all-to-all trade is not viable in this market, and Professor Johannes cites no such evidence. In a Canadian Fixed Income Forum survey¹⁷⁴ of both buy-side and sell-side market participants in the Canadian bond market that was published by the Bank of Canada, “Close to 45% of survey respondents believe access to an all-to-all trading platform (as opposed to dealer-to-dealer or client-to-dealer platforms) for trading Canadian dollar fixed income instruments would improve market liquidity.”

¹⁶⁹ These are Euro-Schatz Futures, Euro-Bobl Futures, Euro-Bund Futures, Euro-Buxl® Futures, Euro-BTP Futures, Short-Term Euro-BTP Futures, Mid-Term Euro-BTP Futures, Mid-Term Euro-OAT Futures, Euro-OAT Futures, Euro-BONO Futures, and CONF Futures. “Eurex Monthly Statistics,” Eurex, August 2019, https://www.eurexchange.com/resource/blob/1621236/866efbb83183353f95efa51422261a9e/data/monthlystat_201908.pdf.

¹⁷⁰ Long Gilt Future, “Daily Volumes for Long Gilt Future (Monthly),” Intercontinental Exchange, 2019, <https://www.theice.com/marketdata/reports/>.

¹⁷¹ “Eurex Monthly Statistics,” Eurex, August 2019, p. 113, at https://www.eurexchange.com/resource/blob/1621236/866efbb83183353f95efa51422261a9e/data/monthlystat_201908.pdf.

¹⁷² Léanne Berger-Soucy, Corey Garriott and André Usche, “Government of Canada Fixed-Income Market Ecology,” Bank of Canada Staff Discussion Paper 2018-10, September 2018, <https://www.bankofcanada.ca/wp-content/uploads/2018/09/sdp2018-10.pdf>.

¹⁷³ Exchange-Traded Bonds (TB), ASX, 2019, <https://www.asx.com.au/products/bonds/exchange-traded-treasury-bonds.htm>.

¹⁷⁴ “CFIF Survey Results on Liquidity, Transparency and Market Access in Canadian Fixed Income Markets,” Bank of Canada, October 2016, p. 28, <https://www.bankofcanada.ca/wp-content/uploads/2016/10/cfif-survey-overview-031016.pdf>.

178. When citing Natasha Khan of the Bank of Canada on her research¹⁷⁵ concerning the impact of electronification of the interdealer broker market for Canadian government bonds, Professor Johannes characterizes her work by writing “This is strong evidence against Plaintiffs’ experts’ claims that customers receive better pricing on anonymous CLOBs and that there will be large compression in bid-ask spreads and strong increases in trading volumes as a result of electronic AA2A trading.”¹⁷⁶ In fact, however, Dr. Khan does not consider customer trading costs at all. She writes: “However, due to lack of data availability, *we are unable to investigate the impact of these systems on the liquidity of dealer-customer markets*. Nonetheless, data is available for the brokered interdealer market before and after the introduction of the three electronic systems.”¹⁷⁷
179. Indeed, not only does Dr. Khan restrict her attention to bid-offer spreads in the interdealer segment of the market, she only examines the impact of heightened electronic-market price transparency occurring elsewhere in the OTC market on interdealer (IDB) bid-offer spreads. These IDB bids and offers are shown on the same CanPX IDB screens, both before and after the heightened transparency event. That is, there is no change in the trade protocol or venue that produces her data, nor a change in who participates on the venue. The change is instead an increase in price transparency elsewhere in the market, through electronification. She finds that this increased price transparency lowered IDB bid-offer spreads for the 30-year bonds, but that there is no statistically significant effect for the other three bond maturities in her sample. Her results are pertinent to the effects of price transparency on IDB trading costs, but, contrary to Professor Johannes’ characterization, are not about the impact on buy-side trading costs of buy-side access to anonymous all-to-all trade.
180. I have already provided examples of the viability of anonymous all-to-all trade of a range of corporate bonds. Developed-market sovereign bonds are generally far more actively traded than corporate bonds, and are more standardized. Developed-market sovereign bonds also typically have lower credit risk than domestically issued corporate bonds, given the taxation powers of sovereign fiscal authorities, which almost always places the sovereign above almost any other issuers in the same country. The activity level and creditworthiness of high-quality sovereign bonds advantages them over corporate bonds for trade on anonymous all-to-all venues.
181. In my view, overall, the evidence indicates that many developed-market sovereign bonds, like the IRS products at issue, are natural candidates for anonymous all-to-all trade

¹⁷⁵ Natasha Khan, “Impact of Electronic Trading Platforms on the Brokered Interdealer Market for Government of Canada Benchmark Bonds,” Bank of Canada Working Paper 2007-5, February 2007, <https://www.bankofcanada.ca/wp-content/uploads/2010/02/wp07-5.pdf>.

¹⁷⁶ Johannes Rep. ¶166.

¹⁷⁷ Natasha Khan, “Impact of Electronic Trading Platforms on the Brokered Interdealer Market for Government of Canada Benchmark Bonds,” Bank of Canada Working Paper 2007-5, February 2007, p. 3, <https://www.bankofcanada.ca/wp-content/uploads/2010/02/wp07-5.pdf> [emphasis added with italics].

protocols, even though buy-side firms have restricted access to trade platforms offering these protocols.

E. U.S. treasuries

182. Benchmark U.S. treasuries form another example of sovereign bonds that are suitable for anonymous all-to-all trade. Indeed, the bulk of trading in U.S. treasuries was done at the New York Stock Exchange until the mid-1920s, and only then shifted to the OTC market.¹⁷⁸ The first organized exchange in New York, the antecedent of the New York Stock Exchange, was established to trade U.S. government bonds.¹⁷⁹
183. As Professor Johannes states, limit-order-book trade of US treasuries dominates trade for on-the-run (latest-issue benchmark) U.S. treasury notes. Off-the-run treasuries are generally traded by RFQ to dealers. On-the-run trade of US treasuries is conducted using anonymous all-to-all protocols, primarily among major dealers and PTFs. PTFs account for more than half of the trade on these electronic venues, according to a Fed study by Fleming, Mizrach, and Ngyuen.¹⁸⁰ According to data collected from BrokerTec by U.S. Federal Agencies in 2015, hedge funds accounted for about 5% of the trade,¹⁸¹ although these hedge funds may be acting primarily as dealers or PTFs.
184. In his deposition in this matter, Professor Johannes acknowledged that a [REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]
[REDACTED]¹⁸²
185. Professor Johannes also acknowledged that the Mizrach and Neely article that I cited in my opening report concludes that there was spread reduction in the treasuries market after the introduction of eSpeed and BrokerTec.¹⁸³ He stated that they “compute spreads and... report them” and that he did not, as a factual matter, deny that these compressions

¹⁷⁸ The United States Treasury and Federal Reserve Board, “Treasury-Federal Reserve Study of the Government Securities Market,” (1959), Part I, page 95, as cited by Biais and Green (2019).

¹⁷⁹ Bruno Biais and Richard Green, “The Microstructure of the Bond Market in the 20th Century,” *Review of Economic Dynamics*, vol. 33 (2019), pp. 250-271.

¹⁸⁰ Michael Fleming, Bruce Mizrach, and Giang Ngyuen, “The Microstructure of a U.S. Treasury ECN: The BrokerTec Platform,” *Journal of Financial Markets*, vol. 40 (2018), pp. 2-22.

¹⁸¹ This is volume weighted, by instrument, from Table 3.3 (“control days”). Joint Staff Report, “The U.S. Treasury Market on October 15, 2014,” U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission, July 13, 2015, <https://www.sec.gov/files/treasury-market-volatility-10-14-2014-joint-report.pdf>.

¹⁸² Johannes Dep. Tr. 305:9-306:19.

¹⁸³ Johannes Dep. Tr. 281:2-9.

were achieved. He stated that he had “no reason to believe they made any mistakes in computing these numbers.”¹⁸⁴

186. Buyside firms have generally been unable to get direct access to central clearing of their treasuries trades at the Fixed Income Clearing Corporation (FICC). Thus, the treasuries market has been bifurcated into a “two-tier” market in which dealers and PTFs take advantage of anonymous all-to-all trade at BrokerTec and eSpeed, whereas buyside firms trade bilaterally with dealers.
187. According to Michael Koegler, a principal at ViableMkts, a New York-based consultancy specializing in financial technology and market structure, who was quoted in *FinOps*,¹⁸⁵ “The current bifurcated system for US treasuries limits the vast majority of buyside firms to a smaller pool of liquidity than dealers have access to... Buyside firms can’t benefit from trading on all-to-all anonymous order books, which reduce bid/offer spreads.”
188. Although the two main order-book markets for treasuries, BrokerTec and eSpeed, use anonymous all-to-all trade protocols, buyside firms cannot actually retain anonymity because they do not have access to central clearing, and therefore must clear through the dealer that clears their trade. According to *FinOps*, Mr. Koegler remarked that “the buyside suffers from information leakage and price-tiering by dealers since fund managers are forced to participate on platforms offering only fully-disclosed request for quotes. ‘Central clearing for US treasuries for all participants would make the market structure more efficient and better facilitate all-to-all order book trading for fund managers,’ he says.”¹⁸⁶
189. *FinOps* further reported that “Operations managers at several fund management shops gripe that because their trades in US treasuries cannot be cleared through FICC they are at a competitive disadvantage to broker-dealers. In addition to suffering from reduced liquidity and potentially higher trading spreads, fund managers face plenty of risk through bilateral clearing. Should the broker-dealer go bust, the fund manager is out of the money. By contrast, primary dealers are members of FICC which serves as a middleman to guarantee the trade. Primary dealers all contribute to a fund which can be tapped in the event of a counterparty going bust.”¹⁸⁷
190. The report continued: “Why can’t trades in US treasuries executed by fund managers clear through FICC through a clearing member? They do for corporate debt and equity trades through clearing member firms. And they also do for treasury futures contracts

¹⁸⁴ Johannes Dep. Tr. 282:6-13, 283:9-13.

¹⁸⁵ Chris Kentouris, “Central Clearing for US Treasuries: Pipedream or Reality?” *FinOps Report*, January 25, 2018, <https://finopsinfo.com/investments/central-clearing-for-us-treasuries-pipedream-or-reality/>.

¹⁸⁶ Chris Kentouris, “Central Clearing for US Treasuries: Pipedream or Reality?” *FinOps Report*, January 25, 2018, <https://finopsinfo.com/investments/central-clearing-for-us-treasuries-pipedream-or-reality/>.

¹⁸⁷ Chris Kentouris, “Central Clearing for US Treasuries: Pipedream or Reality?” *FinOps Report*, January 25, 2018, <https://finopsinfo.com/investments/central-clearing-for-us-treasuries-pipedream-or-reality/>.

through clearing member firms of the CME's clearinghouse. FinOps could uncover no explanation of the anomaly in the US treasuries other than to offer the explanation of 'that's how the market has historically worked.'"¹⁸⁸

191. A 2015 joint staff report of U.S. financial regulators found that when additional trading firms such as PTFs competed for quote provision, transactions costs shrunk.¹⁸⁹ They state that "the growth in high-speed electronic trading has contributed to the growing presence of PTFs in treasury markets, with these firms now accounting for the majority of trading and providing the vast majority of market depth." Likewise, I would expect significant declines of bid-offer spreads of the four classes of IRS products of concern in this matter, once traded at AA2A venues.
192. When Professor Johannes discusses all-to-all interdealer trading costs for US treasuries, he inappropriately relies on the remarks of Craig Phillips of the U.S. Treasury Department,¹⁹⁰ when Mr. Phillips compared "spreads of D2C transactions with the spread on D2D CLOBS available at the same time." The U.S. Treasury Department's data analysis showed that the vast majority of D2C trades transact within the D2D spread. Here, both Mr. Phillips and Professor Johannes missed the point that roughly half of inter-dealer anonymous all-to-all trade of treasuries is conducted by workup, an all-to-all trade protocol by which buyers and sellers match their orders at the last trade price, and thus at zero effective bid-offer spread and zero price impact.
193. A 2015 New York Fed study¹⁹¹ by Fleming and Ngyuen found that workup accounts for 43% to 56% of total trading volume on the largest treasuries all-to-all trade platform, BrokerTec. In workup trades, buyers and sellers exchange treasuries with no bid-offer spread or price-impact costs. Workup trade continues until it exhausts the matching of buy and seller orders at a frozen price, which is the last transaction price emanating from the platform's limit order book. Workup could not achieve these cost savings without the benefit of price discovery from the anonymous all-to-all platform.
194. Fleming and Ngyuen also found that, via the benefit of workup, 99.5% of market orders achieve execution at the best bid or best offer, because larger orders that might otherwise

¹⁸⁸ Chris Kentouris, "Central Clearing for US Treasuries: Pipedream or Reality?" *FinOps Report*, January 25, 2018, <https://finopsinfo.com/investments/central-clearing-for-us-treasuries-pipedream-or-reality/>.

¹⁸⁹ Joint Staff Report, "The U.S. Treasury Market on October 15, 2014," U.S. Department of the Treasury, Board of Governors of the Federal Reserve System, Federal Reserve Bank of New York, U.S. Securities and Exchange Commission, and U.S. Commodity Futures Trading Commission, July 13, 2015, p. 6, <https://www.sec.gov/files/treasury-market-volatility-10-14-2014-joint-report.pdf>.

¹⁹⁰ "Remarks by Craig Phillips, Counselor to the Secretary, on Market Structure," U.S. Department of the Treasury, December 3, 2018, <https://home.treasury.gov/news/press-releases/sm565>.

¹⁹¹ Michael Fleming and Giang Nguyen, "Order Flow Segmentation and the Role of Dark Trading in the Price Discovery of U.S. Treasury Securities," Federal Reserve Bank of New York Staff Reports, Staff Report No. 624, August 2013.

“walk up the order book” and suffer price-impact costs are typically executed instead during workup trades.

195. My research with Haoxiang Zhu¹⁹² shows why workup and other size-discovery protocols reduce price-impact costs so dramatically and why size discovery is so popular in many financial markets with institutional-size block trades, especially markets for interest rate swaps, index credit default swaps, treasuries, and equities. Counting the costs of delayed trade, size discovery can be disadvantageous for market efficiency, according to my research with Samuel Antill.¹⁹³ In any case, it does not make sense to compare bid-offer spreads without considering the availability of size discovery. If about half of trade is done by size discovery, as is the case with all-to-all (among dealers) treasuries trade, then the effective cost of trade is about half of that represented by the bid-offer spread.
196. Thus, Mr. Phillips and Professor Johannes are making an inappropriate comparison. When they remark that D2C RFQ bid-offer spreads are smaller than D2D CLOB bid-offer spreads, they fail to note that about half of the trade on the same interdealer platform is conducted by a different anonymous all-to-all protocol, workup, that has no bid-offer spread or price impact.
197. In his deposition in this matter, Professor Johannes stated that he did not know whether his report mentioned that interest rate swaps could be traded in the but-for world using “mid-market matching.”¹⁹⁴ Professor Johannes also stated that he did not know whether his report discussed the workup protocol as a possibility for interest rate swaps trading.¹⁹⁵ In fact, workup is used heavily on inter-dealer IRS trade platforms. According to a 2015 white paper by CFTC Chairman Christopher Giancarlo, “It is believed that the work-up process increases wholesale trading liquidity in certain OTC swaps by as much as 50 percent.”¹⁹⁶
198. The Wholesale Market Brokers’ Association, Americas, commented to the CFTC in 2012 on the effect of workup for swaps trading as follows.¹⁹⁷

¹⁹² Darrell Duffie and Haoxiang Zhu, “Size Discovery,” *Review of Financial Studies*, vol. 30, no. 4 (2017), pp. 1095-1150.

¹⁹³ Samuel Antill and Darrell Duffie, “Augmenting Markets with Mechanisms,” Working Paper, Graduate School of Business, Stanford University, August, 2019.

¹⁹⁴ Johannes Dep. Tr. 65:16-66:22.

¹⁹⁵ Johannes Dep. Tr. 66:23-67:17, 75:3-11.

¹⁹⁶ J. Christopher Giancarlo, “Pro-Reform Reconsideration of the CFTC Swaps Trading Rules: Return to Dodd-Frank,” CFTC White Paper, January 29, 2015, <https://www.cftc.gov/sites/default/files/idc/groups/public/@newsroom/documents/file/sefwhitepaper012915.pdf> [footnote omitted].

¹⁹⁷ Letter from Christopher Giancarlo (WMBAA, Chairman) to David A Stawick (CFTC, Secretary), Re: Proposed Rules Prohibiting the Aggregation of Orders to Satisfy Minimum Block Sizes or Cap Size Requirements, and Establishing Eligibility Requirements for Parties to Block Trades (RIN 3038-AD84),

“In this [workup] model, once a price is agreed upon for trading, the resultant trade is reported to market participants and they are offered the opportunity for a brief period of time to “join the trade” by placing a firm bid or offer that is characterized by only two variables (the quantity and whether the order is a “buy” or “sell” order). This results in an increase in liquidity at the most recently established market price. It is vital that any block trade calculation recognize the role that work-up plays in forming liquidity. Work-up enables market participants to assess the markets in real-time and make real-time decisions on trading activity without the fear of moving the market one way or another. This is done to allow the market to find the appropriate pricing levels to optimally complete the transaction without prematurely causing the market impact of a large block trade.”

199. When comparing with execution costs on treasury futures markets, Dr. Culp uses the bid-offer spread as his measure of trading costs without commenting that this bid-offer spread is essentially determined by the exchange minimum tick size rule, rather than by competition for quote provision. For example, Dr. Culp reports an estimated bid-offer spread of 0.22 bps of yield for the 2-year treasury note futures contract. The exchange minimum tick size, once converted from price to yield, is also approximately 0.22 basis points.¹⁹⁸
200. Professor Johannes’ presentation of all-to-all bid-offer spreads for treasuries also ignores the minimum tick size in that market. In November 2018, the minimum tick size for 2-year treasury notes, set by rules on BrokerTec and eSpeed, were reduced by 50%. The rule change was shown in a 2019 New York Fed study by Fleming, Ngyuen, and Ruela¹⁹⁹ to have significantly reduced the bid-offer spread by roughly the same amount. While it need not always be the case that a reduction in a rule-based minimum tick size improves market liquidity in an unqualified sense, the authors of this study stated: “Overall, we conclude that the [2-year treasury note] tick size reduction improves market quality.” In any case, I don’t believe it’s appropriate of the Defendants’ experts to base their assessment of the cost of anonymous all-to-trade of IRS on bid-offer spreads observed at treasury CLOBs, given that these treasury bid-offer spreads are essentially set with a tick-size rule, and moreover could be reduced by 50% with merely a change in the rule. The platform operator has an obvious incentive to ensure that it sets tick size at a level consistent with the viability of platform trade.

August 1, 2012,
<https://comments.cftc.gov/PublicComments/ViewComment.aspx?id=58343&SearchText=>.

¹⁹⁸ For the conversion from price to yield, I assumed a duration of 1.75 years.

¹⁹⁹ Michael Fleming, Giang Nguyen, Francisco Ruela, “Tick Size Change and Market Quality in the U.S. Treasury Market,” Federal Reserve Bank of New York Staff Reports, Staff Report No. 886, April 2019.